TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

May 1958

YR 60 H 7

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MAY 15 1958
DETROIT

No. 5 in a series

Right off the Wire

An automatic ultrasonic welder makes tack welds without heat at the rate of 200 inches per minute.

Miniature mercury lamps are being used in batteries of twelve for night aerial photography. An area of sixteen square miles can be lighted from an altitude of 20,000 feet.

A new electron microscope permits the examination of opaque specimens.

An electronic converter makes any radio an appliance timer.

A three-year test of a 43,000-pound ship's propeller made of nialite (nickel-cadmium bronze) shows no wear caused by erosion or cavitation.

D. W. Kitchin and O. S. Pratt of Simplex recently made two major discoveries in studying corona spaces in cables — one, by observing internal pressure decrease, and another by mapping with silver cyanide solution.

A distillation column sixteen feet high and made entirely of glass is said to be the world's largest. It will be used to make silicon carbide with impurities of only one part in ten billion.

It has been demonstrated for the first time that petroleum is a colloidal dispersion. This knowledge may help in obtaining greater recovery from existing oil reserves.

A giant machine to hold large assemblies for welding can lift, tilt and rotate weights up to forty tons.

A tiny photoflash bulb is said to give the same amount of light as one four times its size. It uses zirconium rolled to foil gauge.

Over 1300 industrial concerns in this country are now using radioactive byproducts. About 200 were added to this list during the last year.

Air power for generators in remote installations, such as aids to air or marine navigation, can be supplied by a modern windmill which has a thirty-foot, three-bladed "propeller." It maintains constant speed.

Temperatures as high as 3500°F. are resisted by a new molded plastic.

Polyethylene is now made with an ultraviolet inhibitor and is said to last four times longer than the unprotected form.

Further information on these news items and on Simplex cable is available from any Simplex office. Please be specific in your requests.

Nuclear reactors may be used as economical sources of heat to convert coal into gaseous or liquid fuels.

A stereo cartridge to play the 45-45 Westrex groove records is in production.

South Carolina is putting its automobile drivers' licenses on photosensitive, anodized aluminum. They will be used for four years.

Speeds of 15,000 miles per hour and temperatures as high as 18,000°F. can be reached momentarily in a new wind tunnel being built to test missile nose cones.

"Silicone Insulation as Applied to Wire and Cable" is the title of a research paper by P. H. Ware of Simplex. This insulation is trade named "Thermoplex".

Flexible tanks of rubberized fabric are being made for use in the oil fields. They hold 15,000 gallons, but can be rolled into a package eight feet by two and one half feet when empty.

Kraft paper, shrunk after forming, is being used for shopping bags and multi-walled sacks. It stretches under tension and is said to be twenty per cent stronger than papers now in use for this purpose.

A portable scale that needs no pit is made for roadside weighing. It can handle vehicles sixty feet long weighing seventy tons.

Protection plus

C-L-X (sealex) is a continuous, lightweight, exterior metallic cable sheath recently introduced by Simplex. Impervious to gases, chemicals and water, C-L-X is ideal for almost any installation including aerial applications, industrial distribution and direct burial, as shown above. Practically any type of cable core can be used for such applications as power, control, signal and communication installations.

Other features include extreme pliability, ease of handling, long life, easy installation and relocation, and color coding for voltage or circuit identification.

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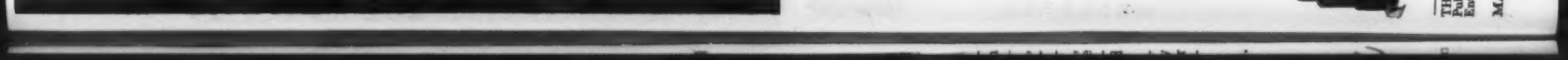
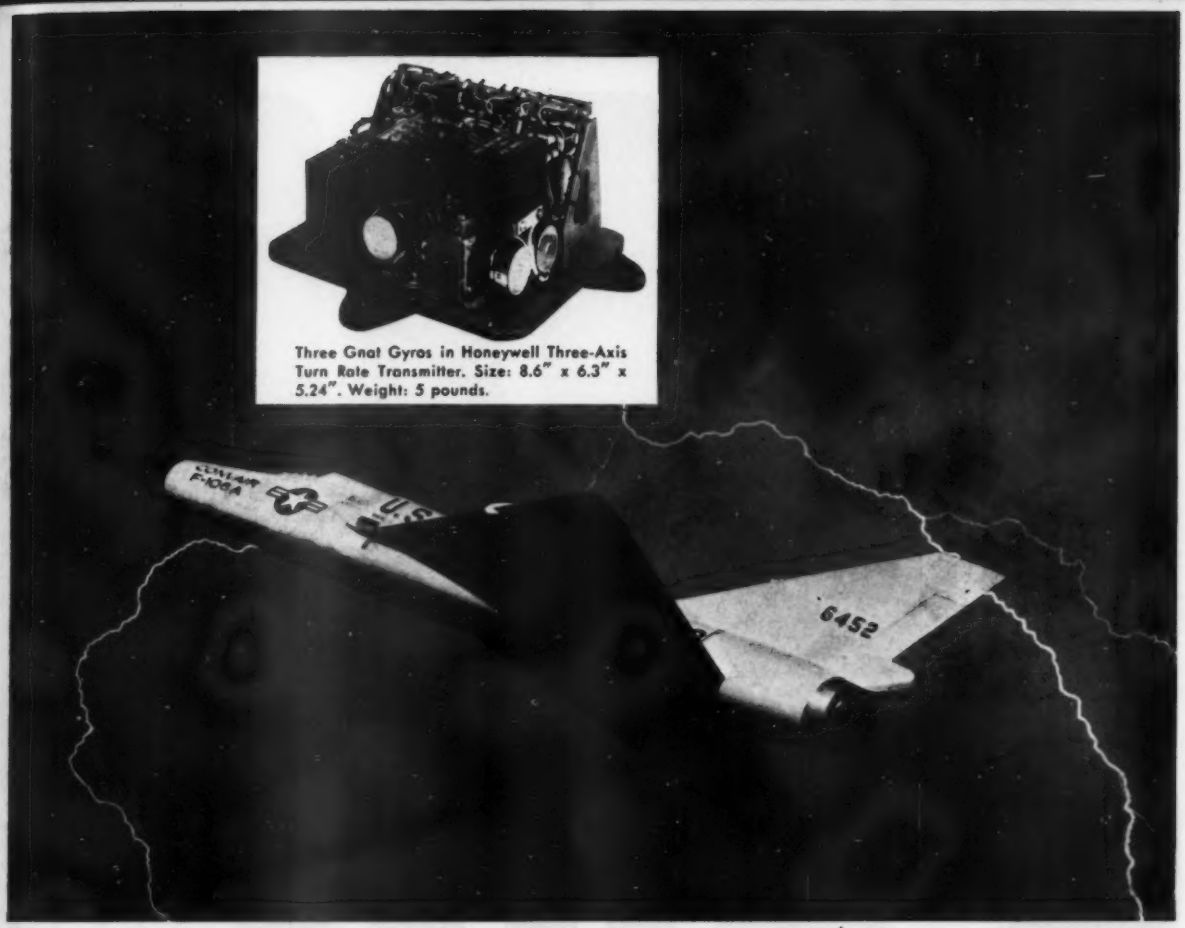
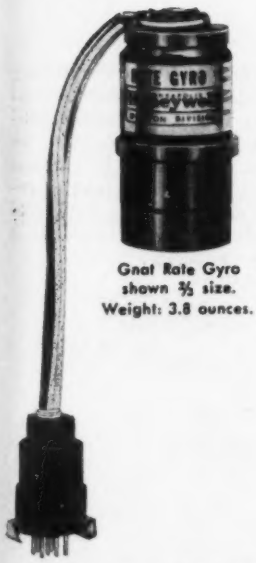




Convair F-106 all-weather jet interceptor incorporates Honeywell Three-Axis Turn Rate Transmitter in flight control damper system

Three-axis control at *all* speeds and altitudes



Gnat Rate Gyro shown ⅔ size. Weight: 3.8 ounces.

The Honeywell Three-Axis Turn Rate Transmitter, featuring three Gnat miniaturized gyros, was selected for the new Convair F-106 "Delta Dart" all-weather jet interceptor. Built into the stability augmentation sub-system of the jet's flight control system, the Transmitter detects rate of turn about the yaw, pitch and roll axes and responds with an output signal whose voltage is proportional to these input rates of turn.

This system is designed to operate under the most severe environmental conditions to which a combat aircraft might be subjected. The Honeywell Gnat Rate Gyros are easily capable of withstanding the severe shock, vibration and temperature requirements of this application and as such are mounted directly upon the base casting without shock mounts to optimize dynamic characteristics of the system.

The electronic portion of the Turn Rate Transmitter amplifies and demodulates the Gyro output signals to provide polarity reversing d-c outputs proportional to the corresponding input rate to each Gyro.

Investigate Honeywell's ability to develop, engineer and produce flight control systems for today's most advanced aircraft and missiles. Write for Bulletin GN to Minneapolis-Honeywell, Boston Division, Dept. 1, 1400 Soldiers Field Road, Boston 35, Mass.

Honeywell

Military Products Group

THE TECHNOLOGY REVIEW, May, 1958, Vol. LX, No. 7. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn., Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00: Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

Olivetti makes office equipment of 10 distinct types. This wide range of product has given Olivetti an unusually well-rounded familiarity with the problems of the modern office; which, in turn, has helped Olivetti to develop money-saving solutions to many of those problems, and to build them into its machines.

In the U.S.A. Olivetti presently offers its electric, standard, and portable typewriters and its adding, calculating and bookkeeping machines. Olivetti also makes teleprinters, dictation machines, visible filing systems, filing cabinets, and machine tools. Spare parts and service are quickly available through branch offices and through dealers in 48 states. Olivetti Corporation of America, 580 Fifth Avenue, New York 36, N.Y.

The Olivetti Tetractys printing calculator is unique in several ways. It is *fast*. It has *two* registers. It has an automatic constant and memory. It combines calculations, eliminating re-entries, and gives individual totals and grand totals. It is easy to operate.

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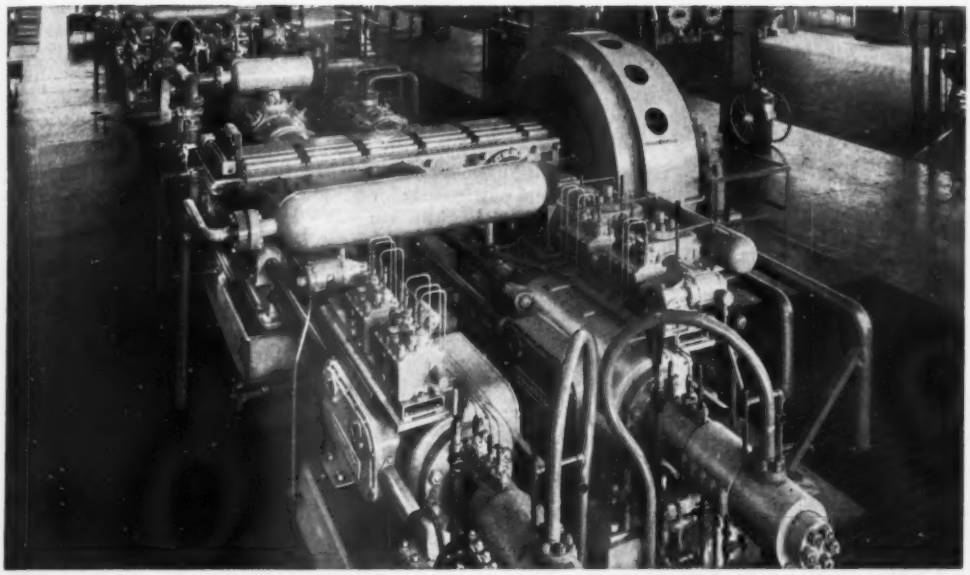
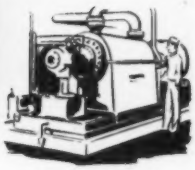
with INGERSOLL-RAND



Seven electric-driven Ingersoll-Rand reciprocating compressors totaling 21,900 horsepower are at work in this large ammonia synthesis plant. The units in the foreground compress mixed gases to more than 12,000 pounds per square inch.

also means LEADERSHIP in



Centrifugal Pumps

Here's What Compressor Engineering at Ingersoll-Rand can mean to you...

TODAY, air power is one of the industry's most vital requirements. Compressed air and gases are the "breath of life" to chemical and process industries, refineries, power plants, steel mills, manufacturing plants, mines and all types of construction jobs. Hence, compressor and blower engineering offers an exciting and ever-expanding field of challenging opportunities that are virtually industry-wide.

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Ingersoll-Rand also manufactures pumps, rock drills, diesel and gas engines, vacuum equipment, blowers, air and electric tools and specialized industrial machinery as illustrated at the right. These products require engineering know-how in their design, manufacture and field application.

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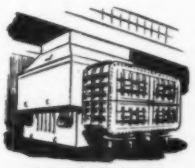
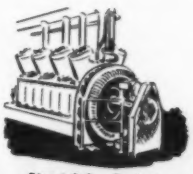


Steam Condensers



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THE TABULAR VIEW

Tranquil Cove. — For many years the pages of The Review have been enriched by RAYMOND E. HANSON, '03, whose serene landscape photographs have helped counterbalance the hurly-burly of an industrial way of life. Early in his career, Mr. Hanson was professionally engaged in chemistry. For at least the last quarter of a century, he has been a free-lance photographer; he became internationally known for his writings on photography and particularly for the artistic and technical quality of his pictorial prints. He was a leading member of the Boston Camera Club, which he joined in 1918. He was a keen student, rising early in the morning, as he said, "because there is so much to learn." His visits to The Review Office invariably brought forth discussions on history, ethics, philosophy, education, or science and, almost incidentally, on photography. Mr. Hanson died at his home in Melrose, Mass., on March 28; but examples of his work (as on pages 342 and 360 of this issue) can be drawn on for future presentation to Review readers.

Engineer's Role. — Support for the important professional work of engineers was given by Acting President J. A. STRATTON, '23, at the Regional Meeting in Washington, D.C., on March 1. Except for brief introductory remarks relating specifically to the Regional Conference, Dr. Stratton's remarks appear on page 351 of this issue. Biographical details of Dr. Stratton's brilliant career were recorded in Tabular View in the February Review.

American Science. — Also at the Regional Conference in Washington on March 1, JAMES R. KILLIAN, JR., '26, surveyed needs of American science. Dr. Killian's remarks (which appear on page 353) have particular significance since they represent the point of view of Special Assistant to the President for Science and Technology. Dr. Killian's achievements were chronicled in the December, 1957, issue of The Review, which announced his appointment to his present important post in Washington.

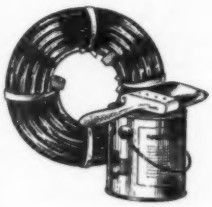
Beyond Nuclear Physics. — The current status of particle physics is reviewed (page 357) by M. STANLEY LIVINGSTON, Professor of Physics at M.I.T. and, since 1956, Director of the Cambridge Electron Accelerator at Harvard University. Text of Dr. Livingston's article was originally presented at the Regional Meeting in Washington on March 1. Professor Livingston received the A.B. from Pomona College in 1926, the M.A. from Dartmouth College in 1928, and the Ph.D. from the University of California in 1931.

Our Foreign Aid. — More than 60 trips to various parts of the world (particularly to the Middle East and Far East) together with direct contacts with foreign governments, native labor, and a variety of economic, engineering, and human relations problems provide the background for the article (page 359) by HARRY A. KULJIAN, '19. The Kuljian Corporation, established in Philadelphia in 1931, has had responsibility for designing and building more than 70 power plants on four continents. As its president, Mr. Kuljian has had ample opportunity to assess the workings of our Foreign Aid Program; his views and proposals have attracted the attention of members of Congress. In 1953 Mr. Kuljian was awarded the D.Eng. from Drexel Institute of Technology and in 1955 was Pennsylvania's "Engineer of the Year."

. . . tires or toys

. . . ribbons or ropes

. . . house paints or hoses



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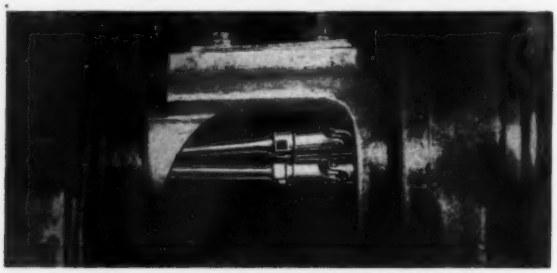

The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint. **The solution** was a Curtis Universal Joint of the same size but higher torque.

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MAIL RETURNS

RETARDING INFLUENCES ON AERONAUTICS

FROM TEDDY F. WALKOWICZ, '41:

In the February, 1958, issue of The Review, J. L. B. Blizard presents an interesting discussion of "Invention in Flight." It is soundly concluded that inventions generally come from many lands, and that it is still an open issue whether the free world, or the collective world, will reap the greatest benefits of their assembled talents [in the field of aeronautics].

It is unfortunate that Dr. Blizard does not argue and support this thesis more strongly. True enough, the comparison of flight in nature with flight by man has many interesting aspects. However, quite apart from the more obvious technical oversimplifications (for example, those in Table I on page 205 and the statement on page 216 that: "The rocket engine is the only one which will operate above 50,000 feet), one can take serious issue with the main point: that progress in man's flight has been impeded largely by a lack of free flow of communication.

For example, more rapid progress in the helicopter field has been impeded by very difficult problems in dynamics and structural fatigue, and still waits for the advent of low-cost, shaft-turbine power plants. Making it sound as if earlier publication of da Vinci's works would have speeded things up appears to be stretching the point, to say the least.

Similarly, however uncommunicative Goddard may have been about his work, the reasons for the 10-year lag between United States and German rocket development are rather more complicated than "unfortunate compartmentalization of American rocket research."

After all, we were all told by Dr. Bush in *Modern Arms and Free Men* in 1949 that a free society was bound to stay ahead in science and technology, because there were fewer impediments to communication in a free society than in one as security-conscious as the communist state. Yet, as evidenced by the Sputniks, Soviet progress in aeronautics since the end of World War II appears to have been rather more rapid than that of the United States. Why? The reasons are several.

First, as Dr. Blizard asserts, the free flow of communications is of some importance. Here in the United States, this problem has become rather acute during the past five years because of a top-level philosophy on the dissemination of information, which has been unsound both in principle and in practice. However, this problem alone, although serious enough to be a

(Continued on page 380)

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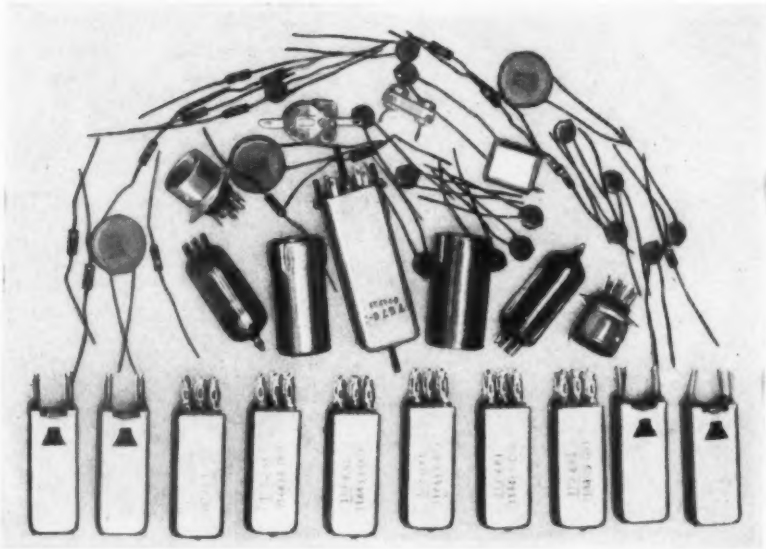

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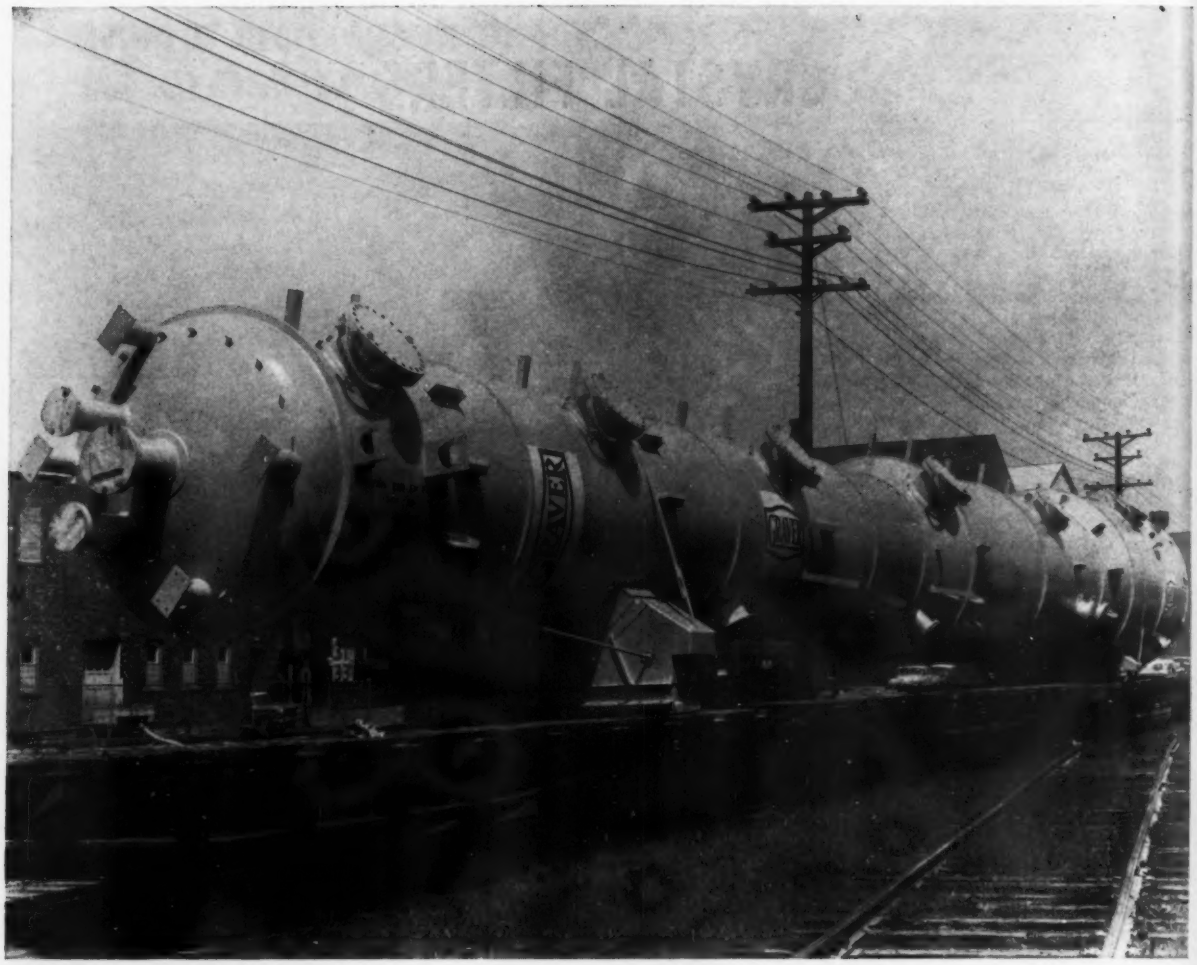

Fractionator Towers . . . By the Three Carload

When it comes to making big towers, Graver has fabricated many in its 100 years association with the petroleum and chemical industries.

One of the latest is shown here—all 90 tons of it. This is a fractionator for refinery feed stocks. Formed of A285-C firebox quality steel for pressures up to 220 psig and temperatures to 650°, the tower is 107′ 5″ overall by 7′, 9′, and 11′ diameters. Radio-graphed and then stress-relieved in Graver's big heat-treating furnace, the finished tower is another proof of Graver's skills in fabricating large processing equipment.

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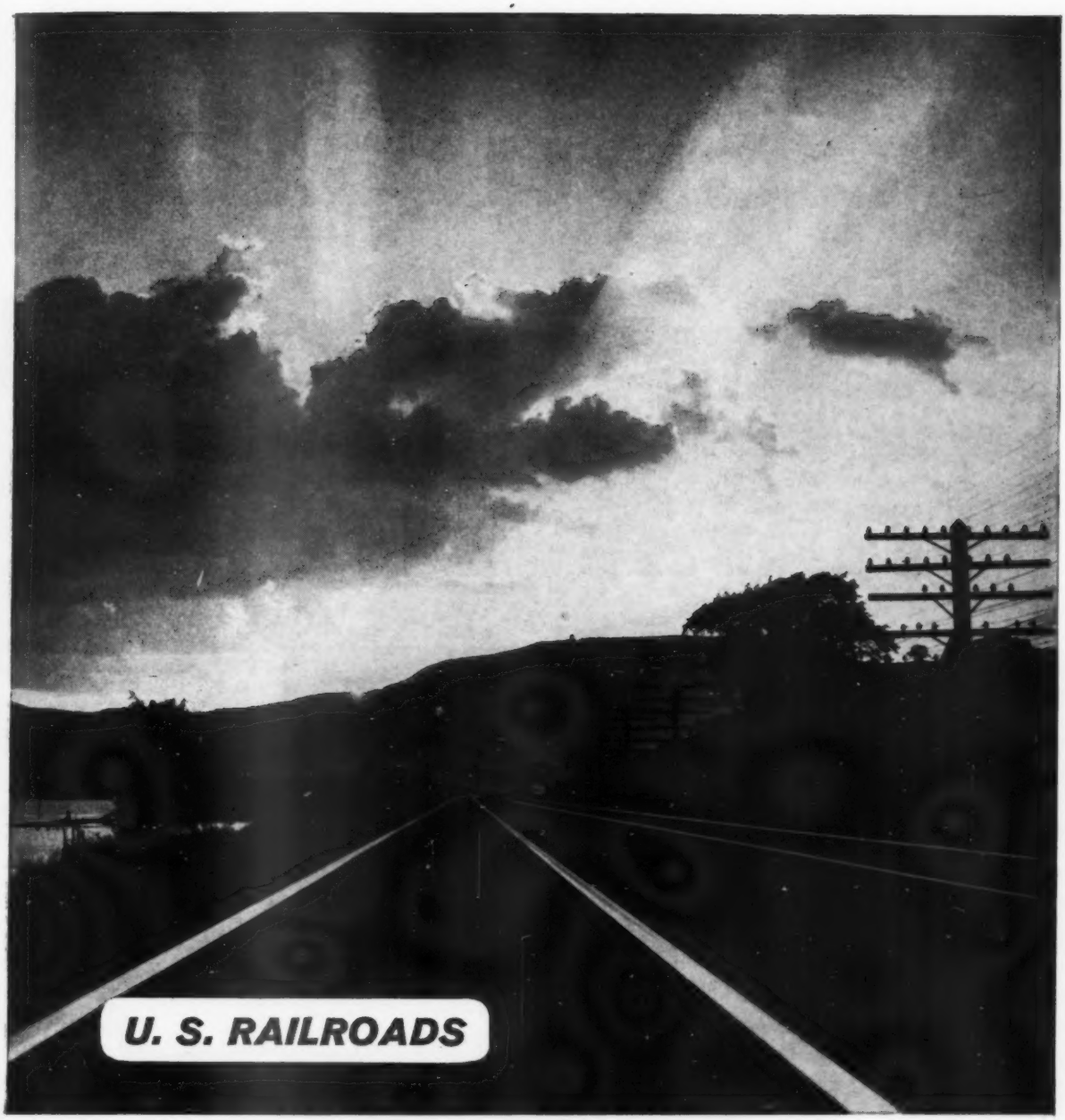

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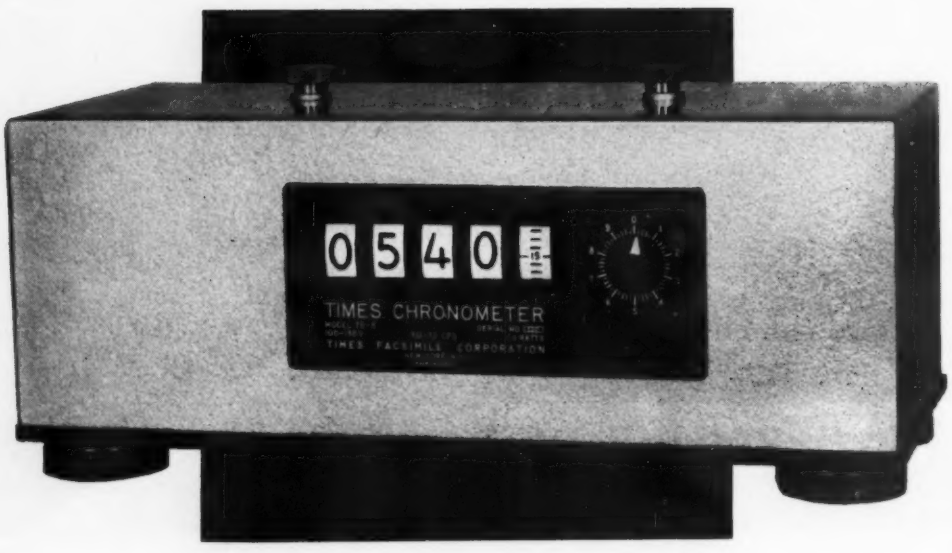

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BELOW — A few of the far-flung projects designed and constructed by Lummus

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Project	Location
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Sulfuric Acid Plant, Inland Chemicals Canada Limited	Fort Saskatchewan, Alberta, Canada
High Pressure Acetylene Chemicals Plant, General Aniline & Film Corp.	Calvert City, Kentucky, U.S.A.
Phenol-Acetone Plant, Progil-Electrochimie	Pont de Claix, France
Ethylene Oxide Plant for Petrochemicals Ltd.	Partington, England

COMPLETE REFINERIES

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Burmah-Shell Oil Company	Bombay, India
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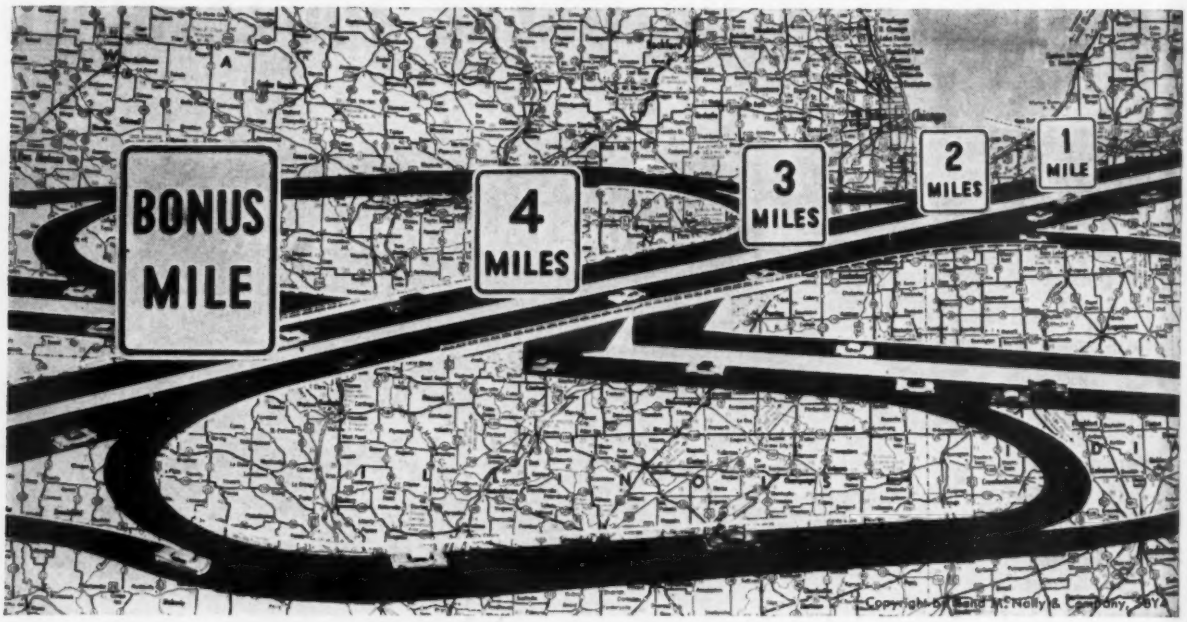

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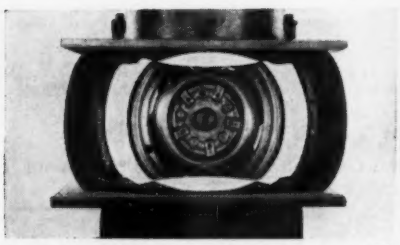

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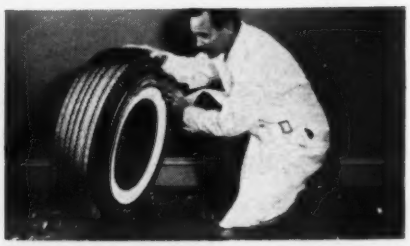

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THE TECHNOLOGY REVIEW

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS for MAY, 1958, Vol. 60, No. 7

WATERFRONT AND NATIVE MARKET AT PORT-AU-PRINCE, HAITI — Front Cover
Photograph by Paul J. Woolf

TRANQUIL COVE, ROCKPORT HARBOR — Frontispiece 342
Photograph by Raymond E. Hanson

THE ROLE OF THE ENGINEER — By J. A. Stratton 351
Preservation of the high mission of the engineering profession becomes of utmost importance as technical education moves toward the scientific and theoretical

UNDERWRITING THE FUTURE STRENGTH OF AMERICAN SCIENCE AND TECHNOLOGY — By James R. Killian, Jr. 353
Currently we must give attention to at least five requirements for augmenting our scholarship and our research effectiveness

BEYOND NUCLEAR PHYSICS — By M. Stanley Livingston 357
Atomic and nuclear structure are reasonably well understood. We stand at the threshold of exciting new discoveries about the fundamental particles of which our universe is composed

OUR FOREIGN AID PROGRAM — AN ENGINEER'S APPRAISAL — By Harry A. Kuljian 359
Our aid in education, agriculture, and public health has been of outstanding value, but we have not had equal success in aiding industry in foreign nations

THE TABULAR VIEW — 332
Contributors and contributions to this issue

MAIL RETURNS — 334
Letter from Review Reader

THE TREND OF AFFAIRS — 343
Relating to the Massachusetts Institute of Technology

EDITOR:
B. Dudley

BUSINESS MANAGER:
R. T. Jope

CIRCULATION MANAGER:
D. P. Severance

EDITORIAL ASSOCIATES:
Paul Cohen
J. R. Killian, Jr.
F. W. Nordsiek
J. J. Rowlands

EDITORIAL STAFF:
Ruth King

BUSINESS STAFF:
Madeline R. McCormick

PUBLISHER:
H. E. Lobdell

Round House, Oahu Railway and Land Company, Honolulu, Hawaii

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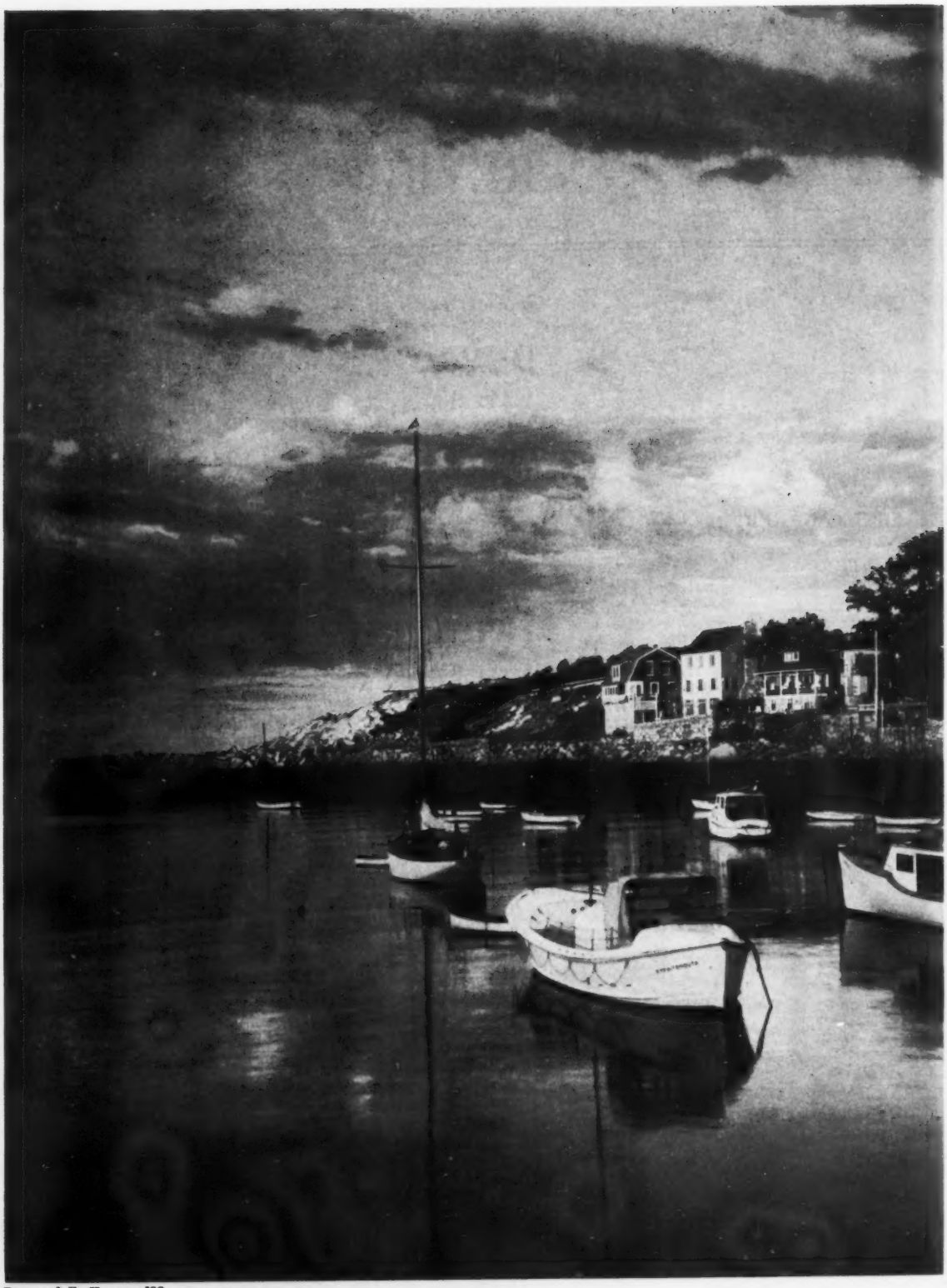


Raymond E. Hanson, '03

Tranquil Cove

Permanently captured in this photograph of Rockport Harbor is the serene calm at the end of a day well-spent, fittingly expressed in Alfred, Lord Tennyson's lines, "Twilight and evening bell, and after that the dark."

The Technology Review

VOL. 60, NO. 7 MAY, 1958

The Trend of Affairs

M.I.T. Increases Tuition

■ In a letter dated March 18, addressed to all M.I.T. students, as well as to the parents or guardians of undergraduate students, J. A. Stratton, '23, Acting President, announced an increase in tuition from $1,100 to $1,300 per academic year. This increase was authorized by the Corporation, at its last meeting on March 3, and the increase will become effective with the beginning of the fall semester in 1958.

The increase has become necessary, said Dr. Stratton, because of steadily rising costs of operating an educational institution. Last year the Institute incurred a deficit of a quarter of a million dollars; without relief, this deficit may be expected to rise to approximately $900,000 in another year.

Members of the Corporation and the Administration are anxious that no student now enrolled shall find it necessary to leave the Institute for financial reasons related to the current rise in tuition. Increases in scholarship aid, increased use of the Technology Loan Fund, and initiation of a plan of installment payments of tuition are planned to assist students to meet the increased costs of education. Even with the present increase, tuition meets less than half the cost of education at the Institute, said Dr. Stratton. In his letter to students, Dr. Stratton wrote:

We are keenly aware that the cost of an M.I.T. education constitutes for many students and their families a financial burden of major proportion. We think it proper that those who can do so should pay a fair share of the actual cost of their education. However, it is our desire to assist in every possible way those who lack the immediate financial resources. Accordingly we shall make substantial adjustments in scholarship aid and in the funds available for loans. It is our firm intent that no student presently enrolled shall find it necessary to leave the Institute for financial reasons related to the forthcoming increase.

The decision to increase tuition has been forced upon us by the steadily mounting costs of operating an educational institution such as M.I.T. Even at the new rate the student will contribute considerably less than half of the actual cost to the Institute of his education. As a consequence the Institute incurred last year a deficit of the order of a quarter of a million dollars, and without some relief in the form of a tuition increase, we anticipate that this would rise to approximately $900,000 at the end of another year. These are the hard facts which have made our difficult decision inescapable.

To alleviate the immediate impact of the tuition change upon our students, the total scholarship aid for undergraduates and graduate students will be increased more than 20 per cent by drawing upon such limited funds as are available for this purpose. At the same time every effort is being made to secure additional outside scholarship support to replenish and augment these funds.

The Technology Loan Fund this year has lent over $450,000 without any collateral other than confidence in the character of our students. Next year the funds available for loans will be increased by nearly 50 per cent to help meet the increased costs. Any student in good academic standing whose financial planning appropriately provides for payments of the costs of his education after graduation may draw upon this source for direct assistance. Loans may be granted up to the amount of full tuition each year, payable after graduation. Our first priority will be toward those students who will require assistance to meet the increase in tuition. For the first time we shall begin to make the Fund available to entering freshmen.

We shall continue our efforts to find convenient part-time employment in the M.I.T. dining halls, dormitories, laboratories, libraries and elsewhere on campus for those students desiring such work. The Placement Office is making a concerted effort to assist students in finding summer employment.

The Institute recognizes that the payment of tuition in a large lump sum at the beginning of each term may present a serious problem to many students. To ease this burden we shall institute a plan of installment payments for all or any part of the total fees – both tuition and dormitory charges – that may be incurred by a student during his residence. Payments may be made either by mail or in person on a monthly basis, or according to whatever plan best fits individual needs, without interest or carrying charges. However, we require that all payments be completed by the end of each academic year.

We had hoped that the proposed increase could be deferred for another year. This has proved impossible and we have reluctantly recognized the necessity of going ahead with the change this coming fall. However, it is my sincere belief that these other steps taken concurrently will insure the successful completion of your education.

New Corporation Member

■ A new life member of the Institute's Corporation is George M. Humphrey, steel corporation executive, who was born in Cheboygan, Mich., on March 8, 1890. The son of a prominent member of the Michigan bar, Mr. Humphrey received a public school education at Saginaw, Mich., and later entered the University of Michigan from which he was graduated in 1912 with an LL.B. degree.

After graduation, he was admitted to the bar in Michigan and practiced law in Saginaw with Humphrey, Grant and Humphrey until 1918, when he entered the service of the M. A. Hanna Company in Cleveland as general attorney. He became executive vice-president of this firm in 1924 and president in 1929. Mr. Humphrey served as chairman of the Board of M. A. Hanna Company from May, 1952, until his appointment as Secretary of the U.S. Treasury under President Eisenhower, when he resigned all of his corporate offices.

At present Mr. Humphrey is honorary chairman of the board and director of the M. A. Hanna Company. He also serves as chairman of the Board of National Steel Corporation, and is a director of Canada and Dominion Sugar Company, Ltd., and of the Pittsburgh Consolidation Coal Company.

Named "Man-of-the-Year for 1957" by the National Association of Manufacturers, in that year *Forbes Magazine* also recognized Mr. Humphrey as one of the "Fifty Foremost Business Leaders." He has been the recipient of honorary degrees from 14 colleges and universities.

Frank Turgeon, Jr., F.R.P.S.

George M. Humphrey

. . . life member of the M.I.T. Corporation. Mr. Humphrey is honorary chairman of the board and director of the M. A. Hanna Company of Cleveland.

Olive Barnard Room

■ Spontaneity marked the acceptance of a plan for the establishment of an Olive Barnard Memorial. Miss Barnard, who died on August 28, 1957, joined the Department of Business and Engineering Administration in 1919 and had been an administrative assistant for more than 25 years. Her air of serenity, coupled with a profound humor, for which she was loved and respected, formed the basis for an unusually understanding relationship with Course XV students in the School of Industrial Management.

William L. Stewart, Jr. and Hugh S. Ferguson, graduates of Course XV in the Class of 1923, are co-chairmen of the Committee for the Olive Barnard Memorial. This committee sought a memorial that would be tangible and continuing, one that would meet a serious need of the School, one which would be dedicated primarily to the students, and one appropriate to the life purposes of a great counselor.

Therefore, to provide such a memorial in Miss Barnard's name, it was proposed to convert the lobby of the Sloan Building into both a student lounge and a "special functions" room. Adjoining this will be an Alumni Office and Alumni Secretary for the School of Industrial Management, who will also add an element of personal welcome to visitors in the School's lobby. Miss Barbara Doyle joined the School in this capacity in February, and is presently situated in Miss Barnard's former office. She brings to this new office a broad background in administration and personnel work, both in department stores (New York and Boston) and in technical research and development at the M.I.T. Lincoln Laboratory.

Miss Barnard was an educator in the highest sense. Although her influence on graduate students was profound, her major concern was the students who come here as youths and leave as men. Miss Barnard believed in putting first things first and thought in terms of needs rather than in terms of luxuries. The committee hopes that the memorial may be concerned with those things that were Miss Barnard's chief concerns: with the passage through life which each of us makes; with whether we are successes in the large sense rather than merely in a monetary way; with what is best in the concept of "counseling."

The conversion of the lobby of the Sloan Building into the Olive Barnard Room and an Alumni Secretary's Office, as worked out in tentative form by the architect is estimated to cost in excess of $50,000. Basic plans for the project call for a well-carpeted area furnished with comfortable chairs and settees, adequate lighting, and additional facilities to allow either the serving of dinner to 80 guests or the holding of meetings for about 150 people. The Barnard Memorial will provide space for many kinds of student activities, especially professional association meetings.

The extent of the memorial is dependent on the money received. No "drive" for subscriptions is contemplated. Contributions made payable to "M.I.T.: Barnard Fund" may be sent to the Olive Barnard Memorial Committee, Room 52–456, M.I.T.

Vitamin C and Wounds

■ Vitamin C, the citrus fruit vitamin, holds a mysterious key to the rapid healing of wounds, according to Bernard S. Gould, '32, Associate Professor of Biochemistry at the Institute.

Earlier studies by Dr. Gould and others have proved that animals deprived of vitamin C cannot heal wounds and that there is a direct relationship between the amount of vitamin C in the tissues and the ability to heal wounds. But until now no one knew whether vitamin C acted directly in the healing process or whether it mediated hormonal or other mechanisms that controlled the healing process.

"Now," says Professor Gould, "it is clear that vitamin C is specific and that it acts directly at the site of healing. It is the necessary agent that makes possible the very rapid production of the fibrous network (collagen) which is the basis of the healing process."

According to Dr. Gould, the production of collagen in wound healing and in early growth proceeds at a rate enormously accelerated compared to the extremely slow rate encountered once the individual reaches maturity. Indeed, more than one mechanism may be involved – one, dependent upon vitamin C, during early rapid growth and in wound healing and another, perhaps relatively independent of vitamin C, for the maintenance of body collagen.

It has also been shown that vitamin C is required for the maintenance of newly healed tissue and appears to be essential for a considerable time after apparent healing. Having found that vitamin C itself is specific for the healing process and acts chiefly at the site of healing, Dr. Gould points out, the problem now is to discover the mechanism by which vitamin C becomes effective.

Dr. Gould's work is supported by a grant from the National Institutes of Health, U.S. Public Health Service.

Film on Food Technology

■ The Department of Food Technology at the Institute recently has produced a new film called "New Horizons in Food Technology," directed primarily toward high school science students to interest these students in careers in the largest single industry, the fabulous food industry – an industry which amounts to well over 26 per cent of the nation's economy.

In this age when many people, both young and old alike, are imbued with the importance of Sputnik, the nuclear age, and the engineering sciences, one forgets the very basis upon which one is existing, namely, that of food.

The food industry is not only the largest single industry in this country today but it is the most stable and ever increasing, due to the increase in our population and due to the increase of our standard of living, and also the American housewife's desire for convenience.

This industry is in need of scientists well trained in food technology, and the film which has been produced by the M.I.T. Department of Food Technology is available for showing to interested high schools and to science organizations.

On the Horizon

June 16, 1958 – 24th Alumni Day, 1958, M.I.T., Campus in Cambridge.

November 8, 1958 – 13th M.I.T. Alumni Regional Conference, Albuquerque, N.M.

Regatta on Onondaga

■ The M.I.T. Crew will journey to Syracuse on June 21 as one of the participants from 13 colleges and universities to row in the annual Intercollegiate Rowing Association Regatta on Lake Onondaga, near Syracuse. This event, formerly called the Poughkeepsie Regatta, when it was held on the Hudson River, will schedule three races – for the varsity, junior varsity, and freshmen.

Probable entrants in this year's I.R.A. Regatta are: Boston University, California, Columbia, Cornell, Dartmouth, M.I.T., Navy, Pennsylvania, Princeton, Rutgers, Stanford, Syracuse, and Wisconsin. All except California participated last June when an estimated 11,000 persons witnessed the regatta.

Competition in this year's regatta is expected to be the keenest in years, since the Cornell varsity eight that dominated the feature three-mile race for the past three years has been depleted by graduation.

Tickets are on sale, and further information may be obtained, through the M.I.T. Athletic Department and the Syracuse Regatta Association Headquarters, Syracuse University Athletic Department, Syracuse 10, N.Y. Space for alumni tent reunions will be available, according to the regatta officials.

Housing Official Lectures

■ Yngve Larsson of Sweden, Dean of European housing and planning officials, came to the Institute as visiting lecturer for a week in April. A former member of both the Swedish parliament and the Stockholm city council, Dr. Larsson participated in lectures and seminars in M.I.T.'s Department of City and Regional Planning.

Dr. Larsson is the first distinguished visitor to be brought to M.I.T. through the Robert D. Kohn Fund whose establishment was announced on April 3 by Professor Pietro Belluschi, Dean of the School of Architecture and Planning. Donor of the Kohn Fund, said Dean Belluschi, is Civic Films, Inc., a nonprofit corporation whose president is Clarence S. Stein, world-famous architect and planner.

In large part Dr. Larsson has been responsible for the basic policy of Stockholm's development, according to Professor John T. Howard, '35, Head of the Department of City and Regional Planning at M.I.T. And in planning and housing circles, Professor Howard pointed out, Stockholm is considered one of the leading cities of the world in the quality and scale of its planning.

Dr. Larsson has been a part of the Stockholm city government for 40 years and has held a variety of important posts, including chairmanship of the Housing Department and the Housing Commission.

Individuals Noteworthy

■ Prominent in the spring news were 33 promotions, elections, or appointments as set forth below:

Clarence D. Howe, '07, as Chancellor, Dalhousie University, Halifax, Nova Scotia . . . *Francis W. Sears, '20,* and *Sanborn C. Brown, '44,* respectively, as President and as Treasurer, American Association of Physics Teachers . . .

Bryant Essick, '22, as a Trustee, Occidental College . . . *Peter C. Dirksen, '24,* as Vice-president and General Manager, New Bedford Gas and Edison Light Company . . . *Sargent D. Heath, '24,* as a Director and Corporation Clerk, Washburn Company, Worcester, Mass. . . .

Francis E. Manley, '24, as Vice-president, Orange and Rockland Utilities, Inc., Nyack, N.Y. . . . *Samuel B. Smith, 2d, '28,* and *Thaddeus L. Sharkey, '28,* respectively, as Consulting Engineer and as Assistant Manager, Rate Department, Ebasco Services, Inc. . . .

Kenneth G. Garside, '29, as Director of Operations, National Cranberry Association . . . *Wade H. Shorter, Jr., '29,* and *John W. Murray, '48,* respectively, as Vice-president and as Manager, Research, Development, and Engineering Operations, Emhart Manufacturing Company, Hartford, Conn. . . .

George T. Logan, '29, as Statistician, Philadelphia Electric Company . . . *Allen Latham, Jr., '30,* and *Joseph J. Snyder, '44,* as Directors, Arthur D. Little, Inc. . . .

Howard T. Orville, '30, as Vice-president, Beckman and Whitley, Inc., San Carlos, Calif. . . . *Willard B. Paine, '30,* as President and Chief Executive Officer, Bendix-Westinghouse Automotive Air Brake Company . . . *Rear Admiral Schuyler N. Pyne, '30,* as Commanding Officer, Brooklyn Navy Yard . . .

Otway W. Rash, 3d, '32, as Regional Vice-president, Carling Brewing Company . . . *Maxwell D. Millard, '33,* as Administrative Vice-president, International and Raw Materials Department, United States Steel Corporation . . . *Anthony N. Mooradian, '34,* as President, Tritex Mills . . .

Ralph G. Adams, Jr., '38, as Chief Engineer, General Products Engineering Department, Bendix Aviation Corporation . . . *Philip V. Darling, '40,* as Planning Director, City of Baltimore . . . *David S. McNally, '41,* as Vice-president and General Manager, Kleinschmidt Laboratories, Inc., Deerfield, Ill. . . .

Neil Burgess, Jr., '41, and *R. Dixon Speas, '40,* respectively, as Vice-president and as Treasurer; and *Luis de Florez, '11, Rear Admiral Calvin M. Bolster, '23, Fred N. Dickerman, '30,* and *Teddy F. Walkowicz, '41,* as members of the Council, Institute of the Aeronautical Sciences . . .

Colonel Richard C. Gibson, '42, as Deputy Chief for Operations, Air Force Missile Development Center, Holloman Air Force Base, N.M. . . . *William R. Lindsay, '46,* as Production Manager, Louisville *Courier-Journal* and *Times,* Louisville, Ky. . . . *Jack J. Jackson, '50,* as Comptroller and Branch Comptroller, respectively, Safeguard Insurance Company and the London and Lancashire Insurance Company, Ltd.

■ Special honors recently announced or awarded to Alumni include:

To *Fred H. Daniels, '11,* the Isaiah Thomas Award, by the Advertising Club of Worcester, Mass. . . . to *J. Warren Horton, '14,* the Distinguished Civilian Service Award, by the United States Navy Department . . .

To *Lawrence H. Flett, '18,* its 1958 Gold Medal for "his research achievements, his devotion to the profession of chemistry, and his long and unselfish promotion of the professional welfare of fellow chemists through the medium of scientific societies," by the American Institute of Chemists . . . to *James R. Killian, Jr., '26,* an honorary doctorate of applied science, by the University of Montreal . . .

To *Bernard M. Gordon, '48,* named as one of nine "Outstanding Young Men of Greater Boston" for 1957, by the Greater Boston Junior Chamber of Commerce . . . to *Richard T. J. Charles, '54,* the 1958 Rossiter W. Raymond Award, by the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Beach Erosion

■ When the characteristics of the sediments comprising natural beaches are examined, in most cases it is found that there is a distinct banding of properties in a direction parallel to the beach. The property showing the sharpest segregation is that of particle diameter. Field samples taken from the surf zone show a large variation in particle size while those taken offshore of the surf zone show a regular decrease of medium particle size as distance in the offshore direction increases.

This observed sorting of sizes was known to be the result of a process of selective onshore-offshore transport, in some manner due to the action of shallow-water waves. It was felt that an understanding of the mechanics of this sorting process would lead to an understanding of the equilibrium characteristics of beaches and the volumetric sand movements indicated by seasonal changes in the pattern of banding.

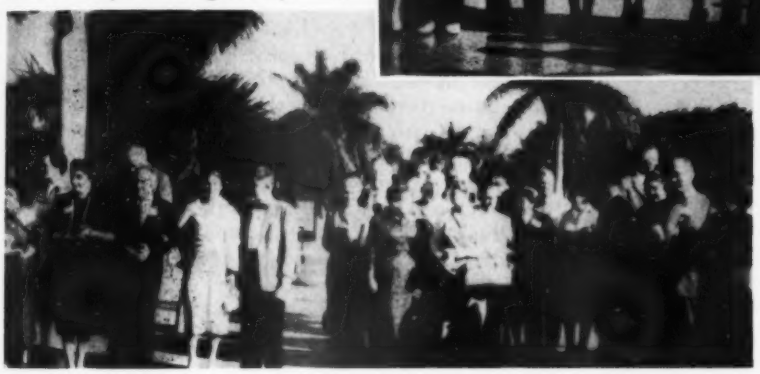
As an oscillatory wave advances into shoaling water, a depth is reached at which the unsteady motion of fluid particles caused by the wave reaches the bottom. As the depth decreases and the wave steepens shoreward of this point, the displacement and velocity of water particles increase in magnitude. Unsteady fluid motion at the bottom results and produces hydrodynamic forces on the sediment particles comprising the beach.

It is recognized that other wave-induced phenomena such as rip and littoral current, breakers, and bed fluidization can cause local motion of bottom sediments, but the general motion due to wave passage is probably responsible for the observed sorting.

During the past several years the Hydrodynamics Laboratory at M.I.T. has carried out an experimental and analytical study of the mechanics of wave-induced sediment motion, under the sponsorship of the Beach Erosion Board, Corps of Engineers, U.S. Army. The work was performed by Luis A. Peralta, '53, and Robert G. Dean, research assistants in Civil Engineering, under the direction of Arthur T. Ippen, Professor of Hydraulics, and the supervision of Peter S. Eagleson, '56, Assistant Professor of Hydraulic Engineering.

Reunion in Cuba

■ On February 21 the Class of 1921 held an unusual reunion in Havana. As these illustrations show, '21 classmates present included (left to right, photograph at right): Mrs. and Mr. George F. B. Owens, Edwin L. Rose, Mrs. Ralph M. Shaw, Jr., Mrs. Edwin L. Rose, Mrs. and Mr. Dugald C. Jackson, Jr., Mr. and Mrs. Philip T. Coffin, Mrs. Carole A. Clarke, Mrs. Robert F. Miller, Carole A. Clarke, Raymond A. St.Laurent, Antonio H. Rodriguez. Shown below are (in reading order): Mrs. Philip A. Nelles, Jr., Mrs. LeRoy M. Hersum, Mrs. Narciso S. Padilla, LeRoy M. Hersum, Mr. Martinez, Mrs. and Mr. George Schnitzler, Mrs. and Mr. Edouard N. Dubé, Mrs. Clarke, Mr. and Mrs. Harry A. Goodman, Mr. and Mrs. John E. Chibás, '31, Mr. Owens, Mrs. Coffin, Mr. Rodriguez, Robert F. Miller, Mrs. and Mr. Willard A. Emery, Mrs. Miller.



The experimental facilities consisted of a glass-walled channel 100 feet long, 2½ feet wide and 3 feet deep, which contained an artificially roughened, fixed, plane beach of variable slope at one end. Waves were generated at the other end by a horizontally reciprocating piston actuated by a hydraulic servomechanism with continuously variable speed and stroke.

The motions of discrete spherical sediment particles of various size and specific gravity were studied statistically on smooth and roughened surfaces of various slope. Under test conditions a set of wave trains was produced, each composed of a different but uniform series of individual "classical" waves.

Preliminary experiments indicated that the bottom sediment reached an oscillatory or quasi-oscillatory motion when, for some portion of each wave cycle, the sum of the instantaneous forces acting exceeded that value necessary to initiate motion.

The instantaneous hydrodynamic forces are oscillatory in nature. Because of wave asymmetry, their net value (temporal average over one cycle) is always in the onshore direction. Gravity, however, provides a unidirectional offshore force. Thus, the particular characteristics of local sediment, wave, and beach will determine an offshore gravity force and a net onshore hydrodynamic force. Depending upon their relative magnitudes, the forces will lead to onshore, offshore, or no net motion of sediment.

At the point of zero net motion, the particles of sediment are in oscillating equilibrium. A particle in a position offshore of the point of zero net sediment motion will move offshore under the driving force of gravity. As it moves offshore it moves into a field of continually weaker fluid velocity so that eventually all motion of this particle ceases. The same particle, in a position onshore of the equilibrium point, will move onshore with considerable convective acceleration due to the increasing predominance of hydrodynamic forces.

In the vicinity of the breaker, the onshore motion is more and more opposed by the backrush from the preceding waves and the sediments come to another point of oscillatory equilibrium. Shoreward of this equilibrium position the magnitude of the periodic excursion of a particle increases as the wave period increases, for then the breaker causing the excursion is out of synchronism with the backrush from the preceding wave.

Analytical studies defined the net velocity of sediment in terms of an unknown resistance coefficient and the unknown thickness of, and velocity distribution within, the bottom boundary layer. These quantities were determined from the above-mentioned tests. Utilizing the point of zero net sediment velocity as the criterion for equilibrium of natural beaches, predictions of local equilibrium size-slope characteristics were made in terms of local water depth and the incident deep-water wave. Comparison with available field data yields results which are in excellent agreement.

Twenty-five Years Ago This Month . . .

■ Expansion of the Institute's program of "aerological research" to gain new knowledge of the atmosphere several miles above the earth was assured by a grant from the Rockefeller Foundation. These studies had as one of their first objectives that of gathering data to aid in developing accurate methods of forecasting local weather conditions.

Since November, 1931, the Department of Meteorology had been making daily weather observations to a height of approximately four miles above New England in a specially equipped airplane (see photograph above). These flights had made it possible to secure daily records of upper-air temperature, barometric pressure, and humidity, as well as observations on fog, haze, ice formation, and clouds.* Preliminary data also had been obtained on the bacteria content of the upper air and on the distribution of pollen and spores of plant diseases.

■ Congratulations were being extended to *George W. Fuller, '90,* upon his being named chairman of the Engineering Foundation; . . . to *Arthur W. Dean, '92,* newly elected President of the Boston Society of Civil Engineers; . . . to *Lewis W. Douglas, '17,* appointed Director of the Budget by the newly inaugurated President, Franklin D. Roosevelt; . . .

And to Davis R. Dewey, Head of the Institute's Department of Economics, for being one of 20 economists to sign an open letter to Mr. Roosevelt urging settlement of the war debts, lowering tariff barriers by reciprocal action, and maintenance of the gold standard as a minimum program for economic recovery. Lower tariffs on manufactured goods were recommended in order to admit additional imports of "diversified manufactures to take out our own agricultural and raw material exports, which," it was felt, "would stimulate prices, purchasing power, and employment." America should encourage and facilitate the prompt restoration of the gold standard abroad, which settlement of interallied debts and tariff reduction would do. World stocks of gold, the letter said, were held to be adequate for all credit needs.

*Observations made March 29, 1933, at altitude 19,300 feet indicated a temperature of *minus* 36.5 degrees F. contrasted with a ground reading of 38 degrees F. above, a range of 74.5 degrees F.

Visiting Committee Report on Library

■ The Visiting Committee on Library* met in the Charles Hayden Memorial Library on December 7, 1957, in the office of William N. Locke, Director of M.I.T. Libraries. Committee members present were: Messrs. Clapp, Henkle, Metcalf, and Chairman Ryer. Professor Locke and Carl F. Floe, '35, Vice-Chancellor of the Institute, met with the Committee.

The accomplishments of the last two years were reviewed. These included improved compensation to Library staff members, a means of materially reducing book losses, establishment of the new "Serials and Journals of the M.I.T. Libraries," a more satisfactory method of supervising student help, staff changes resulting in improved service, and certain physical changes resulting in more efficient use of library space.

Among current problems discussed was the increasing number of requests for library service from industry in the Boston and Cambridge areas. The Committee recommended that Professor Locke study this matter with a view to determining whether some fee might be imposed for service rendered. The advisability of the inauguration of a full-scale industrial reference service had been previously examined, and this study resulted in a recommendation, by the Committee, that such a policy should not be initiated at this time.

The Committee discussed at some length the matter of book selection. It was recognized that it would be very difficult to formulate an acquisition policy, but it was suggested that a few rules be drawn up for guidance of Faculty and Library staff in making purchases of new acquisitions.

After luncheon at Walker Memorial, the Committee considered the future requirements of the Library. It was pointed out that the Dewey Library would soon require more space. As a first step in meeting this need, the Committee recommended that a careful study be made of the possible rearrangement of existing facilities to make better use of the space now available.

Professor Locke described a proposal for a library of Russian Science and Engineering. The purpose of such a library would be to examine and possibly abstract Russian publications on scientific and engineering research and development with a staff of experts in Russian and in science. This is a program which no library in this country now provides. The consummation of the plan would depend on the financial support obtainable from sources other than M.I.T. It was the opinion of the Committee that such a library, under the management or sponsorship of M.I.T., would be of considerable value to the Institute.

It was the feeling of the members of the Visiting Committee present at the meeting that the M.I.T. Libraries were being progressively administered, both as to the present needs of the Institute community and as to its requirements in the foreseeable future.

*Members of this Committee for 1957-1958 are: Edwin D. Ryer, '20, chairman, John W. Barriger, 3d, '21, Luis A. Ferré, '24, Adam K. Stricker, '29, Verner W. Clapp, Theodore P. Ferris, Herman H. Henkle, and Keyes D. Metcalf.

Visiting Committee Report on Architecture

■ The members of the Visiting Committee on the Department of Architecture* held a meeting in the quarters of the Department on the morning of December 3, 1957. Luncheon at the Faculty Club was attended by most of the members of the Department, as well as by the Committee. Following luncheon, several members of the Committee returned to the Department for individual conferences, with members of the departmental staff.

Considerable discussion was given to the proposed establishment of a structural model laboratory. Professor Lawrence B. Anderson, '30, Head of the Department of Architecture, and Paul Weidlinger, lecturer, stated the purpose of the laboratory, and pointed out the increasing need for such facilities, as structural engineering problems steadily depart from traditional and well-known problems, and become research problems of minor, or even major complexity in applied mechanics. Unfortunately, advanced structural engineering is no longer a field of competence for even a well-trained consulting structural engineer. Research investigators have little inclination to work on such problems since they are not usually of fundamental importance in applied mechanics, and frequently require laborious and complex computations and the application of advanced techniques of analysis.

To counteract this trend, which admittedly exists, the Committee investigated two possible solutions: (1) to provide more thorough training of architectural students in structural engineering; and (2) to recapture and focus attention of outstanding structural and research engineers to the major structural problems of contemporary architecture.

It was pointed out that a structural model laboratory would help to accomplish the first objective by providing answers to specific problems by means of experimental stress analysis. The application of model techniques has been used successfully for a number of years in Europe. A structural model laboratory would attract the type of engineers and scientists on whom the architectural profession must depend, and would make valuable contributions in

* Members of this Committee for 1957-1958 are: Thomas C. Desmond, '09, chairman, James M. Barker, '07, Samuel A. Marx, '07, Ieoh M. Pei, '40, William A. Coolidge, Alden B. Dow, O'Neil Ford, Catherine B. Wurster, and Minoru Yamasaki.

Alumni Fund Scholarship Dinner

■ Freshmen and sophomores who have received Alumni Fund Scholarships, either this year or last year, were invited to attend an Alumni Fund Scholarship dinner with members of the Alumni Fund Board and other Fund workers on Monday, March 17. The dinner was held in the Campus Room of the Graduate House, and more than 40 students attended.

An informal program was planned for the evening. Dwight C. Arnold, '27, chairman of the Alumni Fund Board, spoke briefly on the purpose and establishment of the Fund. Mr. Arnold also disclosed that the Alumni Fund is now assisting approximately 50 young men by means of scholarships, and that the Alumni Fund National Scholarships are awarded for the full four-year period.

Major event of the evening was a talk by Nicholas J. Grant, '44, Professor of Metallurgy, who spoke on a visit to Russia he had made last fall and showed several dozen slides of his trip.

M.I.T. Photos

Among those who attended this meeting were (left to right, upper illustration): W. M. Shaw, '61, M. E. Stone, '61, G. S. Stivers, '60, J. T. Rule, '21, Dean of Students; and (left to right, lower photograph): T. P. Pitré, Director of Student Aid, C. S. Tedmon, Jr., '61, D. C. Dunn, '61 (Freshman Class President), R. L. Johnsen, Jr., '61, A. T. Anderson, 3d, '61, D. C. Arnold, '27, chairman, Fund Board.

research and education in architecture. M.I.T. would be a logical place for such a laboratory.

Beginning in September, 1957, the Department of Architecture has offered a new elective, the Visual Arts. Albert Bush-Brown, Assistant Professor of Architectural History, explained how the History and Criticism courses introduce students to architecture, painting, and sculpture through illustrated lectures, group conferences, and museum trips. The first half of the course is focused upon the Renaissance in Italy; the second, upon the last 100 years. Robert O. Preusser, Assistant Professor of Visual Design, spoke about creative participation in art and how his Studio course was designed to encourage greater comprehension of the visual arts. Formulation of this Studio course presented a challenge: to make it meaningful to students who have not had previous art experience, who do not intend to become professional artists, and who represent a wide range of scientific and engineering professional interests.

Pietro Belluschi, Dean of the School of Architecture and Planning, described the need for a landscape architect to be available to students for seminars and criticism in an area of present weakness.

Eduardo F. Catalano, Professor of Architecture, and Ernest N. Gelotte, '23, Associate Professor of Construction, were also present during most of the meeting and made valuable contributions to the discussions. The Committee briefly visited the studios and was shown slides and models of student work and visual aid methods by Gyorgy Kepes, Professor of Visual Design, and Richard Filipowski, Associate Professor of Visual Design.

The Visiting Committee report on the Department of Architecture was received for publication in The Review on March 17, 1958.

Meeting No. 330

■ The 330th meeting of the Alumni Council of the M.I.T. Alumni Association was opened by Executive Committee member, Vincent T. Estabrook, '36, at 7:40 P.M. on Monday, March 31. Attending this meeting, held at the M.I.T. Faculty Club, were 135 members and guests of the Association, including an unusually large number of past presidents of the Council, many of whom were seated at the head table.

Orders of business included approval of minutes of the previous meeting, and acceptance of the report by Donald P. Severance, '38, Secretary, announcing change in class affiliation of one Alumnus. In addition, Mr. Severance reported that between November 8 and March 27, ten M.I.T. clubs in the loop formed by Tampa, Mexico City, San Francisco, and Hartford had been visited by 19 members of the Institute family. Twelve representatives from the Boston area attended the Regional Meeting in Washington, D.C. on March 1.

It was reported that contributions to the 1958 Alumni Fund had been made by 10,318 Alumni, as of March 28, which is 300 more than last year at the same time. This year's Fund, totaling $330,000, was almost $47,000 ahead of the Fund last year at the corresponding time of the year. Joseph E. Conrad, Regional Director of the Alumni Fund, was reported as completing his tour of regions whose activity is expected to be finished by mid-April. As many as 97 per cent of the members of the Alumni Council have contributed to the 1958 Fund, and it is anticipated that complete participation will be achieved by the 331st Council meeting.

After the short business session, Malcolm G. Kispert, '44, Vice-chancellor, and Charles L. Miller, '51, Assistant Professor of Surveying, spoke on recent activities at M.I.T. with which they are closely associated.

With the aid of slides, Mr. Kispert discussed three aspects of the Institute's increase in tuition, next fall, from $1,100 to $1,300 per academic year: (1) What are the conditions which made an increase necessary? (2) What is the capacity of students to pay? (3) What modifications in Student Aid will be made to help students meet the increase in tuition?

The Institute's academic budget, as projected into 1959–1960, shows significant planned increases in salaries and wages, which, incidentally, amount to three-quarters of the total academic expenses. Currently it appears that there will be a deficit of $213,000 for the present fiscal year, which will have to be met from unrestricted funds. Despite the tuition increase, the Administration expects to balance the 1958–1959 budget only through the use of $500,000 in unrestricted funds; and the projected deficit for the year of 1959–1960 is $210,000.

There is a general agreement among the private institutions that, if they are to meet their long-range financial problems, tuition must cover a higher proportion of total cost that it has in the past, and at the same time student aid must be greatly augmented to assist students who cannot afford higher tuition rates. There is a very serious problem of implementing this change in philosophy with respect to tuition, since any one institution which tries it alone would be subjecting itself to great financial risk.

Mr. Kispert presented figures showing tuition changes in a number of other private institutions. Many educational institutions have mandatory fees in addition to the tuition, whereas at M.I.T., the tuition is an all-inclusive fee. Another slide showed the relationship, since 1940, between the change in tuition at M.I.T. and the change in average tuition at 11 other private institutions. This was also compared with the disposable personal income after taxes. Between 1940 and 1958, tuition at M.I.T. has not advanced as rapidly as that in other private colleges, nor has it increased as rapidly as the disposable personal income during the same period.

A study of the annual income of the families of the M.I.T. Freshman Class of this past fall (from an analysis sponsored by the Undergraduate Association) showed that the median income is $8,000 per year and that one-third of M.I.T.'s freshmen come from homes whose annual income is between $5,000 and $8,000; another 16 per cent come from families reported to have annual incomes of less than $5,000.

The starting salaries of S.B. graduates have increased from $225 to $475, or 2.11 times, since the end of World War II. During this same period, tuition has increased only 1.8 times, although the new tuition will bring the Institute's tuition to 2.17 times its 1946–1947 level.

(*Continued on page 378*)

The Role of the Engineer

Preservation of the high mission of the engineering profession becomes of utmost importance as technical education moves toward the scientific and theoretical

by J. A. STRATTON

At the 12th M.I.T. Alumni Regional Conference, held in Washington, D.C., on March 1, the Institute's Acting President delivered the address presented on these pages. The conference, whose topic was "The Outlook for Science in America," presented an opportunity to tell in one short day about a few of the more exciting advances on the several fronts of science and engineering. After preliminary remarks especially suited to the occasion and locale, Dr. Stratton presented his principal remarks in the following words –

We have been hearing a great deal about science lately. It has been our good fortune that science in this country has now found extraordinarily eloquent spokesmen. Thanks to their efforts there is a growing comprehension of the crucial role of science in our society; of the reasons why it is imperative that the teaching of science in our schools be improved; and why there is the most pressing need for the encouragement of basic research.

Now the true aim of pure science is to know and to understand. Without an understanding of the principles that underlie the raw data of Nature, progress is slow and empirical. But to *know* is not enough. If science is to be more than an academic pastime, men must also *do*. To do – to translate into tangible benefits the advances of science – that is the function of the engineer. Science and engineering together constitute a vast and continuous spectrum of human effort. No one part of that spectrum, from the ultraviolet of basic research to the infrared of manufacture, can flourish or even subsist without the remainder.

It is my impression that in our concern to stimulate science, we may be overlooking and indeed neglecting the role of the engineer. And so it is on his behalf that I should like to make these few remarks. For engineers are not merely the draftsmen and plumbers of science. Our airplanes, our missiles, our great weapons systems, the stupendous growth and development of industrial processes are all the direct products of American engineering.

If, now, the public confuses engineering with science, if the press last month hailed Wernher von Braun as a top "missile scientist," rather than the excellent engineer which he is, the blame must be borne in some measure by the engineering profession itself. It seems to me that engineers have been notably inarticulate in proclaiming the high mission of their profession. One cannot escape the conclusion that, as a group, engineers to some extent are failing to grasp and to respond to the challenge, the opportunities and the responsibilities that are rightfully theirs. On the one front where engineering meets science, physicists, chemists, and mathematicians have shown themselves seemingly better able to cope with the vastly complex and difficult problems of component and systems development. And on that other front that joins men with machines, one may observe that social scientists are rapidly moving in.

Why is this so, if indeed it is so.

First, consider for a moment the technical origins of our industrial power. This industrial might of the United States has come about because we have achieved the highest rate of productivity per worker, and because we have become a nation of people accustomed to technology.

It is the American engineer who has been the chief architect of this industrial development. But the technology with which he dealt has, until very re-

Ward Allan Howe

The industrial might of the United States has come about because we have achieved a high rate of productivity and because we have become a nation of people accustomed to technology.

Jean Speiser from Black Star

It is the American engineer who has been the architect of our industrial development; engineering education can be both liberal and thorough.

cently, rested far more heavily upon the practical arts than upon science per se. Steelmaking, glassmaking, textile manufacture and the whole gamut of our basic industries arose and grew with a minimum of formal technical training on the part of their leaders.

By contrast, today new industries are springing up on every hand – indeed, almost overnight, as a result of some new specific scientific discovery. To my mind, the most significant economic factor of the mid-Twentieth Century lies in this proliferation of totally new products and processes, coupled directly to the forward march of science. Here are the real and healthy roots of a developing economy and a second industrial revolution.

For 100 years, the education and training of the American engineer has been meshed and in tune with the expanding industrial complex.

Suddenly, largely under the impetus of World War II, the whole scene changes. With great skill and perception our industrial and military leaders are learning to capitalize upon discoveries in this wondrous new world of science. The routine work of engineering technology must and will always remain; but day by day – almost hour by hour – are added new tasks which challenge not only the ingenuity but also the intellectual and educational resources of a totally new kind of engineer. The demands upon the engineering profession are soaring ahead; the horizons are lifting and widening.

We need engineers in quantity, as you well know, to maintain the rhythm of the national industry. But where are the men to come from – men with the depth of professional knowledge and the width of view – to deal with these great new tasks.

They will come, of course, as they have in the past from the schools and colleges of engineering throughout the country. And the question that is pressing upon all of us, who are entrusted with the engineering education of America, is whether we, as educators, have opened our eyes and fully comprehended the great destiny of this profession.

Let it be said to the credit of the engineering institutions that they are clearly awake to the need of a reappraisal. There is scarcely an engineering faculty in the country that is not currently restudying its curriculum, reviewing its aims, revising its methods. Basically the issues are one and the same for every school; if now I seem to speak more particularly for M.I.T., that is because my own responsibilities lie there, and there I see the problems most clearly. To this let me add that the very issues now so hotly debated in the educational world have their counterparts in some of the most perplexing problems of industry and government.

First, may I remind you that engineering is itself many things – a vast domain of many lands. It includes the highly skilled art of the modern technician; it encompasses managerial occupations requiring a consummate knowledge of human behavior; and it has been pushed forward now into areas of systems design, with its array of problems that can be mastered only by the most sophisticated methods of modern science and mathematics.

Every part of this extended domain contains elements essential to the industrial life of the nation. Our great professional societies, such as the institutes of mechanical and electrical engineers, choose to group these activities together in a few large categories. But the fact is that within any one of these traditional branches there is a vast range of professional qualifications. The term "electrical engineer" no longer describes adequately the occupation. Nor can one and the same plan of engineering education be adapted for all.

One of the major criticisms of our lower school system has been the unwillingness to distinguish among students of various aptitudes, ambitions, and intellectual gifts. The professional schools must face the same necessity. I believe that our engineering institutions must begin to redefine their objectives more clearly and design their curricula accordingly. We, too, have our problem of "roles and missions."

Secondly, the dissolving away of the boundaries which traditionally marked off one domain of engineering from another gives rise to an array of new and perplexing questions. Within, let us say, electrical engineering, the range of activities grows wider and wider. At the same time the electrical field is fusing into the mechanical, and it becomes increasingly difficult to distinguish one profession from the other.

Engineering principles and engineering systems cut boldly across these arbitrary barriers, and professional education – particularly at the undergraduate level – must follow suit.

It becomes increasingly clear that whatever departmental structure we may cling to, we must also find better ways of breaking freely out of this compartmentalization. Almost every institution is experimenting with various devices, such as interdepartmental laboratories, research centers, seminars and the like, as a means of providing new syntheses,

(*Concluded on page 372*)

UNDERWRITING THE FUTURE STRENGTH OF American Science and Technology

Currently we must give attention to at least five requirements for augmenting our scholarship and our research effectiveness

by JAMES R. KILLIAN, JR.

I DERIVE deep satisfaction in the opportunity to rejoin my M.I.T. colleagues in welcoming our friends and guests to this Regional Conference and in sharing in this discussion of America's future scientific strength. My position and experience here in Washington have reinforced my conviction that M.I.T. is a major component of our nation's scientific resources and progress, and that she bears an immense responsibility to maintain her long-established role of being a pace-setting institution and one of the world's great centers of scientific research and education.

The fact that I could go on leave of absence to accept my present responsibilities here in Washington, and the fact that so many other members of M.I.T.'s Faculty and Administration have been active in public service continues the strong tradition and policy of the Institute that it has an obligation not only to be strong in its program and activities in Cambridge, but to be generous in making its people available when there is a need for their special talents in the public service. When members of its staff, such as myself, enter the public service it throws increased burdens on those who remain in Cambridge. These burdens they have accepted in good spirit and with great competence, and it should be emphasized that those who pick up these extra burdens are also making important contributions to the nation. Our Chancellor and Acting President, J. A. Stratton, '23, is doing a magnificent job in administering both his office as Chancellor and the Office of the President. Under his skilled and steadfast leadership the Institute is experiencing no loss of momentum; in fact, under his able and firm leadership it is moving steadily ahead.

My remarks are directed at the theme of this meeting. In fulfilling this assignment I wish to dwell on the importance of balance and proportion in our national scientific effort. I include technology, as well as science, in my discussion because they are so closely related and interact upon each other in such profoundly important ways.

Let me make my conviction immediately clear that the United States today is scientifically and technologically strong and growing stronger. I do not believe that we have lost our technological leadership, nor that we are predestined to lose it in the future – provided we do not fail to remedy our weaknesses. We have great strength, we have great resources. We also face relentless, able competition that demands of us poise, high-quality performance, and indefatigable effort.

The first industrial revolution was ushered in by Great Britain. As one of my M.I.T. colleagues has observed, the United States leaped over the first industrial revolution and ushered in the second. Is Russia leapfrogging over the second industrial revolution and moving swiftly toward a third, leaving the United States still preoccupied with the second? It is in the light of this that I discuss our present concerns about the future. The launching of Sputnik and our growing knowledge of the great educational and technological advances in Russia has given many people the idea that the Soviets have achieved a technological superiority over us. In my conviction they have not. In many fields the Soviets have been pushing rapidly ahead, as for example in rocket propulsion, oceanography, theoretical mathematics, space medicine, and certain phases of electronics.

But while this has been taking place, the United States has also been making progress. We continue to be outstandingly strong in nuclear physics, in solid-state physics, in polymer chemistry, and in high-speed calculating machines. In high-energy nuclear physics the Soviets are developing fast and may indeed grow to excel. But in low-energy nuclear physics which is directly related to applications, the outstanding position of the United States is beyond dispute.

What Russian progress has shown is not that leadership has passed from the United States to the U.S.S.R., but that we must expect in the future more examples of Russian challenge to our scientific and technological leadership. Clearly the problem before us is not our leadership in technological strength today; the challenge we face is of the maintenance of this position tomorrow against the challenge of the surging technological revolution occurring in the U.S.S.R. and other countries.

Within our lifetime we have seen how scientific leadership moves from one place to another: in the 1920's and on into the early 30's, a majority of the *fundamental* scientific discoveries were made in Europe, and then there was a shift. In the 1930's and on, the United States became outstanding. After having obtained very few Nobel prizes in science before 1930, the United States has received more than half of those awarded since 1945.

What are some of the things that we must do to maintain our great relative strength in science and

technology? Let me look at some of the requirements for sustaining and augmenting our research effectiveness. We must currently give attention to at least five requirements.

The first of these is the need to make the adjustments in the level of support of research necessary to offset inflation and to meet new needs and opportunities. Administration proposals now before Congress call for a substantial increase in research funds for a number of government agencies and departments. Simply to increase public funds for research, however, is not enough. There must also be an increase in the support provided by private agencies – industry, foundations, and individuals.

Second, we need to stabilize the support of research by both public and private agencies. Starts and stops, *ad hoc* commitments, and modification of research programs have at times kept the national effort off balance, and have occasionally served to dissipate our efforts rather than to augment them.

Third, we seek to achieve a national policy and program for the provision of large scientific instruments, as for example in nuclear physics. Such a national policy and program seems essential if we are to achieve the best distribution of our financial resources. It is recognized that in a number of experimental research fields, our ability to maintain world leadership depends on the availability of new and more powerful research tools. Not only do we need new instruments; we also need to modernize existing research instruments and to find ways to more fully employ machines which we now have.

Are there areas which need more effort and support, as for example, geology, geophysics, meteorology, oceanography, materials research and propulsion? The overlapping or converging areas which involve the participation of more than two sciences are increasing in importance, for example, biophysics and biochemistry, and the application of information theory to neurology and linguistics. There seems to be accumulating evidence that the life sciences are going to be one of the great areas of interest and discovery in the years ahead and warrant increasing attention.

Of course, in pointing out areas which may need more emphasis and support, we must not forget that the direction and course of science is largely determined by the imaginative individual scientist following his own interest and making his own determination of what is most challenging.

The next area which we must give special attention to, in the period immediately ahead, is our organization pattern for scientific research. We have come to think of basic research as finding its natural home in the university, and indeed the university seems to be the best instrument for conducting basic research. This has not always been true, and we may well be entering a period when other forms of organization will compete with the university in the field of basic research. A few great industrial laboratories have strong basic research programs and an increasing number of government-operated or government-sponsored laboratories conduct basic research as indeed they should and must.

Recognizing that other nonuniversity organizations have a compelling need to enter the basic research field, we nevertheless need to give careful attention to the over-all pattern of our basic research effort. Research is an essential part of the effort of a university because the education of scientists must be carried on in an atmosphere of research and through their participation in research activities. If basic research moved out of the universities, we would certainly reduce our capacity to educate future scientists. Indeed as James B. Conant has pointed out, every time we remove a scientist doing basic research from a university, we reduce our capability to train future scientists. As we extend our total national program of research, we need to keep clearly in mind the importance of basic research to the educational strength of our universities and make sure that we do not create a pattern which tends, over the long pull, to attract basic research away from the universities.

But we must also recognize that our research needs are going to require special kinds of institutions separate from the universities. This comes about largely because of the magnitude of equipment and facilities required for much of modern research. The great particle accelerators required by nuclear physics are reaching such size and cost that they no longer can be financed by a university or limited in their use to a single institution. This is becoming true in other fields. In a recent report by the National Academy of Sciences Committee on Meteorology on needs for research and education in meteorology, it urged the establishment of a National Institute of Atmospheric Research which could provide the research facilities on a scale required to cope with the global nature of the meteorological problem as described in this report. These facilities would include: "modern scientific and technological tools such as a large-scale, high-speed electronic computer, a meteorological flight squadron, a laboratory for fundamental research on techniques for probing the atmosphere by electromagnetic radiation, and a laboratory for fundamental research on the use of satellites and rockets as probes of the atmosphere." As envisioned, such an institute might be sponsored by a group of universities and would offer opportunities to university scientists and graduate students, but it would be an autonomous institution standing separate from any single educational institution and planned to serve all institutions responsible for research and education in meteorology. Other examples could be cited where we need to find new institutional patterns and relationships to provide research facilities adequate to deal with modern research techniques but too expensive to be confined to a single institution. We must develop the counterparts of the research institutes in Germany and the U.S.S.R., but we must do it by properly relating them to our universities, and thus avoid a serious weakness in the foreign institutes.

It is also increasingly clear that within institutions it is going to be necessary to create groups of a size sufficiently large to be effective in achieving an integrated approach to certain complex scientific and technological problems. We need to think of how we can establish institutes within educational institutions which make possible a multiple-discipline attack on a problem. M.I.T. has sought to do this through inter-

M.I.T. Photo

The success of engineering education in attracting and holding more first-rate teachers will depend upon accelerating the development of more and stronger graduate programs. The graduate school, and the research associated with it, can provide engineer-teachers with the opportunities for professional activities and growth as engineers which they now find chiefly in practice, outside of educational institutions.

departmental laboratories, as for example the Research Laboratory of Electronics or our Laboratory for Nuclear Science. There re-groupings and consolidations of research activities bring special problems of finance and organization that will require careful attention at the national level in the years ahead. The need for such integrated groups of sufficient size and scope to effectively tackle many of our problems in science and technology should never, however, overshadow the importance of the individual scientist who is working alone or in small groups. He needs to be afforded the opportunity to work in this fashion, and we must find ways to insure him freedom to do so and adequate support. It sometimes proves easier to get support for a project for a large laboratory than it does for the individual scientist working independently with his own graduate students.

In addition to policies affecting basic research, intensive attention must be and is being given to improving the collection and dissemination of scientific, technical, and engineering information.

One of our most immediate tasks is to find mechanisms to make more generally known to the scientific community the availability of information already in hand. While we have problems of collection we have greater problems in distribution. The Librarian of Congress reports that a check of the Library's science receipts, against *Knizhnaia Letopis,* the Soviet national bibliography, indicates that "60 percent of the Soviet materials currently published in the natural sciences and 41 percent of those published in technology are being obtained by the Library. Of the 930 Soviet periodicals (titles) issued in 1950–54, the Library received 501 or 54 percent." The Library of Congress has come to be a great national library of science.

It must be added that there is not enough coverage by the total national translating activity of the significant material being produced by the Soviet bloc. Some 40 Soviet scientific and technical journals are presently being translated: 20 by the federal government and 20 by commercial concerns. In addition, a large number of abstracts of the Soviet literature are being produced in selected technical fields. Translation coverage is particularly inadequate in the fields of biology, physics, geophysics, electronics, and the earth sciences.

As efforts are being made to improve government procedures and efforts in the collection and dissemination of technical information, we need at the same time to give attention to nongovernmental services. We need to find a way to increase the support of numerous United States scientific journals so as to expedite the publication of scientific papers. The situation is such that considerable delays attach to the publication of scientific papers.

Next, we must encourage and provide for the study of the Russian language by increasing numbers of American students. Not only do we need more people who can do the translating that we need; we also need more scientists who can read Soviet scientific publications for their own benefit. A recent estimate indicates that of all the items now published in the field of science in the world, about half are published in

English. The next largest number are published in Russian.

In the field of education there are many improvements available to us for strengthening our scientific and engineering education. The liberal arts colleges are the principal sources of candidates for our graduate schools of science. Recent studies have emphasized how remarkable has been the success of a number of small liberal arts colleges in preparing men and women to become distinguished in science. This points to the importance of still further strengthening the teaching of science in this type of institution, and thus attracting more college students to major in science and to proceed on to graduate school. Increasing the number of science majors in the liberal arts colleges is one of the quickest ways available to us to increase the number of scientists. This will require better laboratory equipment and facilities for these colleges and better professional opportunities for their science professors so that able ones can be attracted and held. It will require, also, an attitude in these institutions that does not underrate science – an attitude, as I shall emphasize later, that sees an understanding of science as one of the requirements of effective, liberal education in our technological society.

Graduate Study in Engineering

Next, we face the requirement that our American schools of engineering and our institutions of technology command more understanding and support. We witness the much-needed mobilization of national understanding and effort on behalf of medical education. We must achieve a comparable national effort in behalf of schools of science and technology, where inadequacy can be as perilous to the national welfare and safety as inadequate medical education.

Until now, our chief reliance in engineering education has been on undergraduate preparation – a system which has not universally risen above the training of technicians. While there will long continue to be an appropriate and essential place for the really professional four-year undergraduate engineering program, it must be supplemented by expanded graduate study in engineering.

Many industries have been ahead of the colleges in recognizing this need. As a consequence, they have evolved training programs of their own to carry their engineers beyond the levels of their four-year undergraduate education. If we had the graduate school capacity to handle these men, it would be more appropriate and advantageous in the long run for them to receive their advanced training in the university, rather than in industry. The engineer, no less than the scientist, can benefit from an atmosphere of uncommitted research, and our technological advance would be more certain if top graduates of four-year engineering courses proceeded on to graduate study.

Against the higher compensation and other attractions offered by industry and other noneducational organizations, engineering schools are now more vulnerable and more in danger of serious deterioration than other educational institutions using scientists. They are more vulnerable, even, than the schools and departments of science. The scientist finds himself at home in our academic environment. This environment is not the natural habitat for engineers, whose professional work lies so much in industry and in the field.

The engineering schools are especially vulnerable now because their young and imaginative graduates and teachers – especially those in the advancing, growing fields of technology – are more in demand for noneducational employment than any other group in our educational institutions.

If engineering education is to meet this challenge and reverse, or even retard, the spreading scarcity of quality in engineering schools, it must find a way to make engineering schools a more attractive environment for top-flight engineers and thus for top-flight teaching of future engineers.

Even though their enrollments have been down, the teaching loads in our engineering schools – exceptions exist, of course – are very high, with the result that their faculties have too little opportunity for the creative work that leads to further professional development both as teachers and engineers. An informed observer recently estimated that only 10-20 per cent of our engineering schools had average teaching loads as low as 12 hours per week or less. When we reflect upon the fact that these institutions are hard-pressed to maintain their present level of staffing, we can readily surmise how difficult it will be greatly to increase enrollments and to enlarge graduate study without further burdening faculties and without a reduction in the quality of education.

The success of engineering education in attracting and holding more first-rate teachers will depend upon accelerating the development of more and stronger graduate programs. The graduate school and the research associated with it can provide engineer-teachers with the opportunities for professional activities and growth as engineers which they now find chiefly in practice outside of educational institutions. In those engineering institutions where strong graduate schools exist and where there is a fruitful alliance with basic science, an environment satisfying to first-rate engineers has been better achieved.

Professional Quality of Engineering

We must achieve this advance in the education of engineers if engineering is to achieve a professional quality and status comparable to that of medicine or law. We will not have solved our engineering manpower problem until we educate more engineers who unmistakably fulfill our society's standards of true professional excellence; men who have a profound understanding of their specialty, coupled with a broad and human culture. The development and growing numbers of this kind of highly educated engineer will serve to make engineering the profession it must be if it is to attract and hold its proper share of high talent.

Next, in my platform for maintaining our technological and scientific leadership, is the correction of the popular image of science.

(Continued on page 374)

Beyond Nuclear Physics

Atomic and nuclear structures are reasonably well understood. We stand at the threshold of exciting new discoveries about the fundamental particles of which our universe is composed

by M. STANLEY LIVINGSTON

PARTICLE accelerators are the "atom smashers" of the public press. They are highly effective research instruments for the study of nuclear physics. The concentrated, focused beams of high-energy particles which they produce (protons, deuterons, electrons, and so on) are used as probes to study the properties of atoms and nuclei. Experiments on the scattering of these high-energy particles, which penetrate even the tiny cores or nuclei of atoms, give information on the size, the electric charge, the magnetic characteristics, and other properties of the atomic nuclei. Bombardment with beams of such high-energy particles can disintegrate nuclei forming new types of atoms with unusual properties, such as radioactivity. Studies of the energies of the resultant fragments can tell how nuclei are bound together by nuclear forces.

We have been able to identify the stable and unstable forms of matter, and to measure the binding energies. Such information has led to rapid development of the field of nuclear physics, with such significant applications as the atomic bomb, nuclear reactors for production of power, and radioactive tracer isotopes for use in medicine and other sciences. Still other applications remain to be exploited, such as the power from thermonuclear fusion – the "taming of the H-bomb."

During the past 25 years, particle accelerators have been developed with almost explosive speed, increasing steadily in size, in particle energy and intensity, and necessarily, in cost. Particle energies are expressed in units of "million electron volts." A particle of one Mev energy could be produced, for example, by making it pass 100 times through a voltage of 10,000 volts. Energy has increased in steps through a sequence of accelerators such as: the voltage-multiplier (1 Mev), the Van de Graaff generator (5 Mev), the cyclotron (20 Mev), the betatron (50 Mev), and the linac or linear accelerator (80 Mev). In 1945, a new principle of synchronous acceleration, discovered simultaneously and independently in Russia and in the United States, led to a new family of higher-energy accelerators, such as: the synchrocyclotron (700 Mev), the electron synchrotron (1,000 Mev or 1 Bev), and proton synchrotrons, such as the cosmotron (3 Bev), bevatron (6 Bev), or the Russian machine which holds the present world's record of 10 Bev.

Of recent years a new development, with which I was associated at the Brookhaven National Laboratory, called "alternating gradient magnetic focusing," has led to the design of a new family of machines of even higher energy. At Brookhaven an AGS machine is under construction which will produce 25 Bev protons; one of the same size is being built at Geneva; similar developments are under way in the U.S.S.R. In this category is the 6 Bev electron synchrotron, the "Cambridge Electron Accelerator," which is a collaborative project of scientists from M.I.T. and Harvard, and supported by the Atomic Energy Commission. It will produce electrons of five to six times higher energy than possible with existing machines.

Furthermore, still higher-energy machines are being planned although funds have not yet been allocated for construction. Chief of these is a 50-Bev electron linear accelerator at Stanford, and a high intensity FFAG (fixed field alternating gradient) machine by a group of scientists in the Midwest, in which special techniques may produce the equivalent of 500-Bev energy. The cost of these large installations would be of the order of $100,000,000 each. Obviously, such large investments of public funds require careful study, and the scientific need for such expensive instruments must be justified.

The significance of the super-energy accelerators, such as the Cambridge electron accelerator and the Brookhaven AGS proton synchrotron, is that they are the instruments needed to explore a new field of science, that of "particle physics," which goes as far beyond nuclear physics as that went beyond atomic physics and chemistry:

(A) *Atomic physics* is the study of the electronic structure of the atom as a miniature solar system, with the nucleus at the center and electrons circling around in planetary-like orbits. Relatively speaking, electrons are at great distances from the nucleus and the binding energies are low. It only requires a few electron volts energy for a bombarding particle to displace the outer electrons from their orbits, or to study the binding energies and other properties of the electronic orbits;

(B) *Nuclear physics* is the study of the properties of the nucleus, a small, compact assemblage of protons and neutrons. The energy required to remove a proton or neutron is about seven Mev in most nuclei. Medium-weight nuclei (center of the periodic table) are the most tightly bound and the most stable.

Heavy nuclei like uranium can fission into two medium-weight fragments with the release of about one Mev energy per particle. Lightweight nuclei can combine into heavier ones (fusion), with the release of several million electron volts of energy per particle. We have learned how to trigger this energy release in fission, as our prehistoric ancestors learned to burn fuel for heat, but we have not learned why. We do not know the origin of, or the detailed properties of, the nuclear force which is involved. In the study of nuclear physics we use accelerators like the Van de Graaff and the cyclotron, with energies up to 20 Mev or somewhat more;

(C) *Particle physics* is the study of the properties of the individual protons, neutrons, and electrons of which matter is composed. The purpose is to break open these fundamental particles and find their internal structure, if it exists. We need to know why these three particles are the only forms of matter which are stable, out of the infinite array of possible other particles. In order to influence these very stable forms of matter, the bombarding particles must be of extremely high energy. It is to produce the necessary billions of volts energy to disrupt and affect the fundamental particles, that the super-energy accelerators are needed.

A significant start has been made in the study of particle physics. The first evidence came from studies of very high-energy cosmic rays; recently, the new super-accelerators have added more information. We now know that when single nucleons (such as the protons which are nuclei of hydrogen) are bombarded by other particles with energies above about 200 Mev, new unstable particles are produced which are called mesons (from the Greek meaning intermediate). These mesons are unstable and break up in a few microseconds, but instruments have been developed which can observe their properties in this short time. The origin of these mesons is obscure. They are apparently formed out of energy, the energy of the bombarding particle, following the Einstein equivalence of mass and energy. They represent an excited state of matter which exists for only a short time, but nevertheless it is a sharp, distinct state which is almost stable. From the existence of these mesons, and measurements of other properties such as their mass, magnetic moment, spin and charge, theoretical physicists have been able to take a long step forward in formulating a tentative theory of matter.

With the higher energies of the cosmotron and bevatron (6 Bev), still other short-lived particles have been observed. Negative protons have been produced at the bevatron in small numbers, but sufficient to measure their properties and conclude that they have identical physical properties to those of the common positive proton in all features except the sign of the charge. This showed that the symmetry in nature, first observed with positive-negative electron pairs, also holds for heavy particles such as the proton. With this proof of symmetry, the experimenters next searched for and found the anti-neutron, identical with the normal neutron in all physical properties but differing in a strangely fundamental way. These twins or mates of the normally stable or fundamental particles are truly "out of this world." They are mirror-images of the normal particles in our world and are completely antipathetic to them. After the positive electron, negative proton, or anti-neutron have been sufficiently slowed down by passing through matter, they interact with their normal cousins in the laboratory and literally blow up. When a negative proton coalesces with a positive proton, the result is a tremendous release of energy — the entire mass energy of the two particles. The same is true for the neutron and anti-neutron. The amount of energy released is nearly one Bev per particle, 1,000 times larger than the amount released per particle by nuclear fission in the atomic bomb.

The unusual properties of incompatibility with normal matter of these anti-particles led to their present name: "strange" particles. Theoretical scientists are just beginning to catch a glimpse of some underlying principles in these phenomena, and are developing theories which predict other classes of particles with differing degrees of "strangeness." A few of these theoretical predictions have been tested by further experiments and seem to be partially correct. So it is possible to see the early beginnings of a theory of matter. But many more years of experiments and more years of theoretical calculations will be required before a valid theory can be established. And in the meantime, scientists in this field are calling for more of the essential tools, the super-energy particle accelerators.

At Cambridge, the scientists of M.I.T. and Harvard interested in this field developed plans several years ago for an accelerator of a unique type which would provide the means of extending the research program in particle physics. A site was chosen at Harvard, and Harvard also offered to administer the project. The Atomic Energy Commission has allocated $6,500,000 for the construction, which is well under way. A laboratory-shop control building will be completed in April and the accelerator housing will be ready for installation of accelerator components by December of this year. A ring of 48 alternating gradient magnets will form a circle of 236-foot diameter, almost large

(*Continued on page 368*)

Electronics and atomic physics deal with the electronic structure of atoms as a miniature solar system. Since the electron was discovered six decades ago, man has progressed to a study of the properties of the nucleus (in nuclear physics) and finally to particle physics in which the properties of elementary particles of nature are investigated.

M.I.T. Photo

Our Foreign Aid Program

—AN ENGINEER'S APPRAISAL

Our aid in education, agriculture, and public health has been of outstanding value, but we have not had equal success in aiding industry in foreign nations

by HARRY A. KULJIAN

Our Foreign Aid program — its accomplishments and its shortcomings — can be best appreciated when related to the industrial status of those nations and areas of the world we seek to benefit. To throw the spotlight on a few basic facts, I would like to take the reader with me on an imaginary trip around the globe.

When we get to Europe and start touring through the industries of England, France, Germany, Switzerland, and Italy, we will find that these countries are as far advanced as we are industrially. There are plenty of jobs for everyone, and nearly everybody keeps busy and makes a good living. But we find a lesser degree of industrial development and a correspondingly lower standard of living throughout the rest of the European continent.

In the Near East, we find practically no large industries in such countries as Turkey, Syria, Lebanon, Iraq, Iran, Trans-Jordan, and Saudi Arabia. There may be refineries where there are oil fields, but in general, industries are very scarce. Most of the people in the Near East are small farmers, who depend upon their own muscular power, or that of domesticated animals, to do the required work for farming.

Water Everywhere — but No Industry

Two great rivers, the Euphrates and the Tigris, flow through Turkey and Syria and then through Iraq into the Persian Gulf. Yet nowhere along their entire course do the farmers obtain any benefit or help from this vast source of power.

The very same thing holds true for both India and Pakistan. The Indus River, which originates in Kashmir, makes its way to the Indian Ocean without dispensing help anywhere along its 2,000 miles. Both countries now realize its great value, especially for irrigation. As soon as their water dispute is solved, they will harness this giant river to generate electric power and use it (as we do at Grand Coulee Dam) to pump water to higher elevations and remote areas. In this way, the two nations can give farmers plenty of water to raise their crops and provide industries with cheap electricity.

When we proceed a little further, to Burma, Thailand, and Indo-China, we find farming is done more effectively, because here at last some of the fresh water resources are put to use for navigation and irrigation purposes. When you fly over Thailand, you see rice fields hour after hour. This is flat country, and it is honeycombed with irrigation canals. The main occupation is farming. The natives tell you with pride that Thailand is the only country in the world where there are no beggars, and where there is plenty of food for everyone.

Japan is the only country in the Far East which has industries like those of Europe and the United States; it is therefore relatively easy for the Japanese to earn a livelihood. The Japanese are also excellent farmers. But Japan is suffering now from a lack of markets for its finished products. In order to find a market for its goods, Japan has been trying hard, during the past few years, to persuade the United States to permit trade between Japan and Communist China.

Why We Began the Marshall Plan

As we are reminded so often, Americans are living in a highly industrialized country where almost everyone can have employment and enjoy a fairly high standard of living. Almost every family has a car, and almost every house boasts of a refrigerator, a vacuum cleaner, a heating system, hot and cold running water, and many other luxuries.

In Europe, some of these comforts may be found in a working man's home. But in the Near East, the Far East, Africa, and most of the South American countries, the working classes have virtually none of these facilities for comfortable living which we have come to regard as necessities.

In most of the countries of Africa and South America, there are practically no industries; for the most part, the people are small farmers, and it is difficult for them to make a living. And the old truism still holds: you cannot expect men with empty stomachs to respond with any enthusiasm to preachments about freedom, equality, or a peaceful world.

Realizing this grave problem after World War II, the United States government initiated the Marshall Plan, with the primary object of rehabilitating war-torn European countries. Later, financial and technical aid was extended to many other countries to promote their industrialization.

Water Power Waiting to be Harnessed

A report issued by the Federal Power Commission in June, 1954, indicates that 94 per cent of the world's surface water supply is still undeveloped. Even in the United States as much as 80 per cent is

still developed! Even if these figures should not be precise, it is clear that vast water resources still remain to be tapped for man's service.

It is encouraging to note that, since the end of World War II, people in many parts of the world have become aroused to the vital need of utilizing their fresh water resources. The result will be to raise their standard of living through proper flood control and through irrigation, which will produce more food, new hope, and peace to the underprivileged peoples of the globe.

Throughout the world at the present time, on an average, about one acre of land per person is being cultivated, and this produces an inadequate diet. We must not only bring new land into production but must make the area we are now cultivating more productive if we are to solve the hunger problem. A large part of the answer lies in the use of water for irrigation, because, on the average, an irrigated acre will produce four times as much as a nonirrigated acre.

I have traveled quite a bit all over the globe and have seen some of the world's great rivers. A very large percentage of the waters of these rivers is now going to waste. We think of the Missouri-Mississippi as a mighty stream. It is – but the Amazon in South America is 20 times as large; the Nile and Congo in Africa is 15 times as large; the Euphrates-Tigris flowing through Turkey-Syria-Iraq, the Indus through India-Pakistan, the Brahmaputra flowing through Tibet-India, and the Yangtse in China – are all very large rivers. In these tremendous rivers lies the potential for a vast agricultural expansion that could easily feed the world.

Raymond E. Hanson, '03

It has been estimated that more than nine-tenths of the world's surface water supply is not yet harnessed. Even in the United States, as much as 80 per cent is still undeveloped.

Where We Have Done a Good Job

We Americans feel that it is our responsibility to build up the educational, sanitation, and industrial systems of underdeveloped countries, to improve their standards of living, and thus maintain their friendship and their strength as a vital part of the free nations of the world.

This goal is a credit to our ideals as a nation, and there can be no doubt that it places our efforts on the highest humanitarian level. Merely because our intentions are good, however, gives us no guarantee that the results of our efforts will be equally good. It is certainly our duty to observe carefully how we are carrying out this magnificent program – and what the results have been to date.

There can be little doubt that our work in the phases of education, agriculture, and public health in these foreign countries has been of outstanding merit. And I can testify from my own experience that the people in these countries, on all levels, are grateful for the aid thus extended to them. These three fields of endeavor touch them very closely. When an adult learns how to read, when a farmer learns how to operate a tractor, or when the village is sprayed with DDT – these are all contacts personal enough to leave a deep impression on these people, and they appreciate the efforts of their benefactor.

A Better Way To Help — in Reverse!

It is quite a different story, however, in the field of industry. There is very little to our credit in this area. One of the reasons may be that our own industries can ill afford to spare the good men we have. For the most part, the men we can hire and send abroad are industrial engineers, who will know how to make a time study, how to market a product, how to introduce a straight-line production method. But few of them, if any, will know how to manufacture sulphate pulp, or how to make rayon from viscose, or how to spin cast-iron pipe, or how to manufacture radio tubes. Yet precisely such knowledge is required to solve the industrial problems that will arise in trying to foster industry in foreign countries. Lacking this highly specialized knowledge, our men have failed to meet the requirements of foreign nations, and the results therefore have been disappointing.

I believe there is a very simple solution to this sad state of affairs. All that is necessary is to reverse our present procedure. Instead of sending our American "experts" abroad, we should invite a carefully selected group of qualified engineers, technicians, and industrial leaders from foreign lands to come to the United States. While they are here they could receive a thorough training in our leading manufacturing plants, laboratories, or engineering offices; they could visit power plants and other installations; in short, they would learn about particular industries first-hand, and under the guidance of leaders in each field. How far superior such training would be, compared to any instruction our technical men could give in a foreign land devoid of industries!

This method has been applied in training a foreign group to take over the operation of a power plant in

(Continued on page 362)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

With the demand for heavier electrical loads constantly on the increase, the demand for electrical equipment of greater capacities also continues to grow. One of those items is circuit breakers.

As a result, design engineers are constantly faced with the problem of not only making breakers of greater load-carrying capacity, but of keeping down their weight and physical size.

In wrestling with just such a problem the design engineers of a leading maker of circuit breakers visualized the extruded copper shape (Fig. "A") as being in two pieces. It was thought that a single shape of that size could not be made satisfactorily. At this point the engineers got together with Revere's T.A. (Technical Advisory) Service. The result was the one-piece copper extrusion shown. Not only was assembly cost reduced but machining time also was saved.

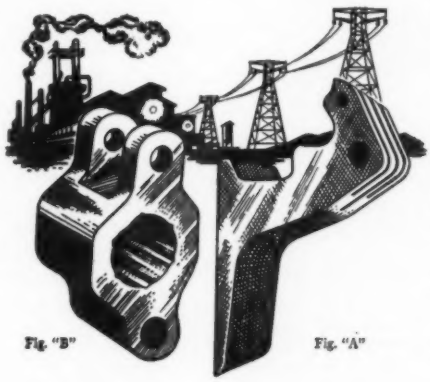


Fig. "B" Fig. "A"

Before arriving at the selection of the Revere Aluminum Extrusion (Fig. "B"), also used in the same circuit breaker, various metals and their properties were studied. First, an aluminum casting was thought to be the answer. Then it was found that an extrusion would weigh less and have a higher strength ratio than a casting. So, by using an aluminum extrusion, both space and weight were saved. Here is an example of where a material costing a little more per pound saved money in the end.

In all, Revere supplied 5 copper and 2 aluminum extrusions, each designed to fit specific requirements. Aluminum was used where strength and weight were the prime consideration, while copper was employed for current-carrying members. The use of extruded shapes saved machining time and costs.

Here you have still another example of Revere supplying the right metal to do the best job with the greatest economy . . . be it aluminum, copper or any one of their alloys. Not only the copper and brass industry but practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the *right* materials.

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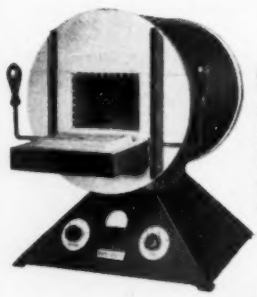

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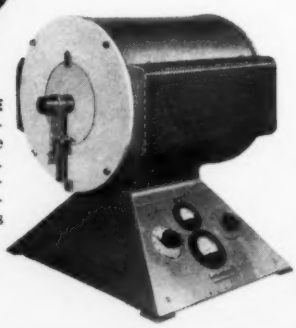

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OUR FOREIGN AID

(Continued from page 360)

India. While obviously on a small scale, this experiment met with much success. I am confident that, if the same principle were to be applied on the larger scale I am suggesting, it would bring gratifying results.

Not the least of the benefits that would flow from this procedure would be the firsthand knowledge of American institutions and our way of life that our foreign guests would absorb while pursuing their training. Returning to their native lands, they would take back with them technical knowledge of a particular industry. But they would also take back an understanding of America that would spread to many others, and thus create a constantly growing attitude of good will toward us. This is really what our Foreign Aid program is intended to accomplish – and we should carry out this aim in the most effective and most economical way.

We Must Mend Our Manners

If we are to continue the present system of sending our men abroad, we should at least make a real effort to remove one cause of friction which seriously hampers the progress of our work. Even with the best intentions in the world, the men who are sent to foreign lands are often so conscious of their mission that they conduct themselves with a patronizing and superior air. All too often, indifference or contempt for foreign dress, customs, and ways of living has damaged our efforts to win the good will of people we really hoped to aid. Numerous instances could be cited in which disrespect for foreign ways has created serious trouble.

Even more than tact and consideration are required of the men who are chosen to carry out work abroad. They should also have a knowledge of the culture and traditions, the economy, commerce and industry, and even the religious customs of the country to which they are assigned. This is not always acquired in a quick refresher course on the airplane going over, or in a cramming session just before the take-off. The increasing attention to humanities courses, under the leadership of John E. Burchard, '23, Dean of the School of Humanities and Social Studies at M.I.T., should help students who recognize the importance of the humanities as a part of their training. The need for sympathetic understanding and tolerance

(Continued on page 364)

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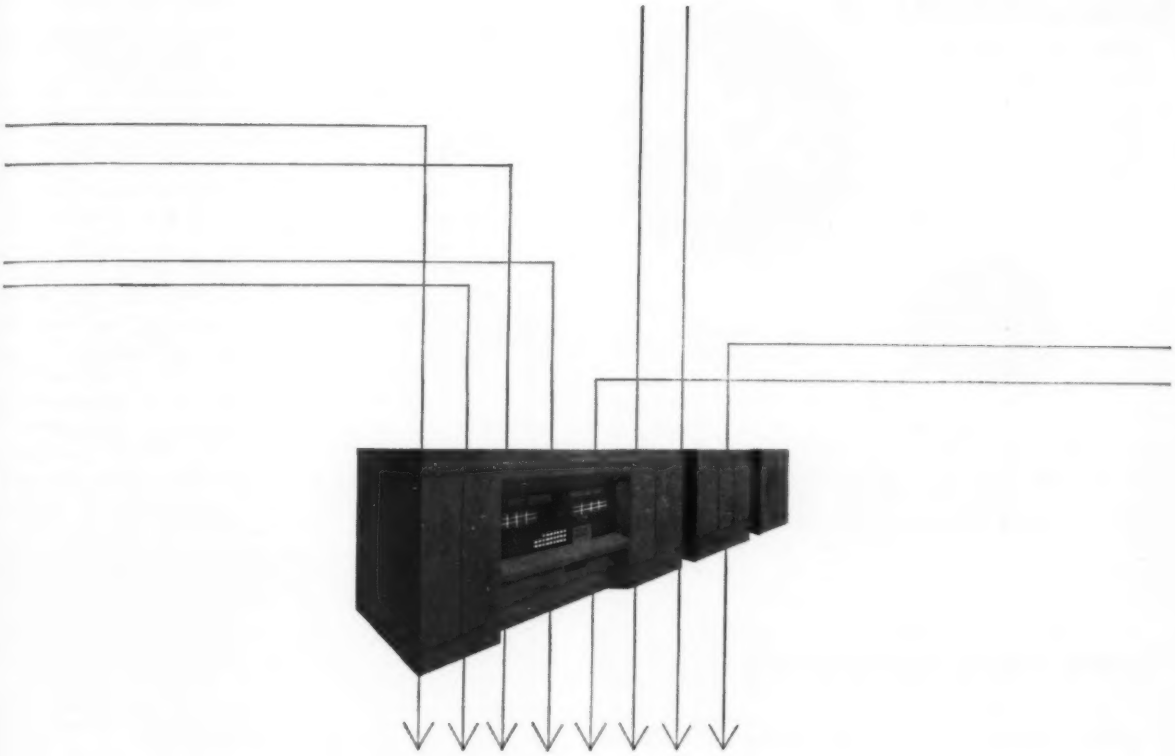

The ORGANIZATION and RETRIEVAL of INFORMATION

The organization and retrieval of large volumes of diverse types of information is rapidly becoming one of today's more serious problems. Major areas where the problem exists include business and industry, the military, the government, and the scientific and engineering community itself.

In its simpler forms, the problem may involve, for example, the automatic handling and analysis of business data such as payrolls, sales and manufacturing figures, insurance premiums, and other essentially statistical data. At the other extreme are certain complex military situations which require the concurrent interpretation, analysis, and integration on a very short time scale of data from a wide variety of sources, including field reports, photographs, news reports, estimates of industrial activity, and the like. In many of these situations, there is the additional requirement to translate the information from a foreign language into English.

The development in recent years of electronic data handling equipment is now making possible the practical solution of many of these problems. Such equipment has the capability to perform arithmetic operations, make decisions among alternatives, store and retrieve large quantities of information, and at high speed automatically perform long, complex sequences of operations.

At Ramo-Wooldridge, work is in progress on advanced information handling systems that are characterized by large volume and widely different forms of information, short time scales, and a variety of uses and users. The scope of the work includes the planning of systems and procedures, programming various types of data handling equipment, and formulation of requirements for new equipment. Research is also under way on the machine translation of foreign languages into English.

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OUR FOREIGN AID

(Continued from page 362)

has been brought home to me by my experience with engineers placed in charge of foreign projects.

Every American engineer and technician abroad who shows an informed understanding and respect for the customs and methods prevailing in his assigned territory will not only smooth his own path, but will also render a decided service to his country by helping to assure the success of this program.

Un-American Policies that Could Stand Revision

There are some serious errors in our method of disbursing money for foreign aid. The funds go directly from our government to the foreign government. The latter then has the choice of loaning this money to private individuals for the development of privately owned industry, or using it to establish a government-owned industry. The second course is often the one chosen. In permitting this to happen, we are discouraging private enterprise in foreign countries while here, at home, we stand as the champion of private initiative and ownership.

Coupled with this unfortunate development is another ill-advised practice which we do nothing to prevent. In too many instances the money which we provide for the equipment of new industries, power plants, and other installations goes to European manufacturers. Most European firms make a practice of

(Continued on page 366)

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Culver City, California

OUR FOREIGN AID

(Continued from page 364)

offering "free" engineering services along with the sale of their products. They are able to convince the foreign bureaucrats – and, incidentally, also convince many of our uninformed International Co-operation Administration men – that since their prices appear to be cheaper they should get the contracts. In thus misusing our own money, we have given preference to European manufacturers rather than to our own American firms, and have helped to establish government-owned industries contrary to American domestic practices.

It would be comparatively easy to correct these unwise policies. We do not want to encourage government-owned industries – certainly not beyond establishment of public works, such as hydroelectric power plants, sewerage and waste-disposal plants, or water works. In making money available for textile, rayon, fertilizer, or general chemical plants, or for iron and steel mills, we should take the precaution of insisting that our money be used only to assist private enterprise, rather than a socialistic economy.

In many instances, it would be wiser to give machinery instead of money, with the stipulation that such machinery is to be made available only to privately owned industries. We should certainly receive assurances and formal agreements from all foreign countries receiving our aid that industries or plants financed and equipped with American funds will not be nationalized in the foreseeable future.

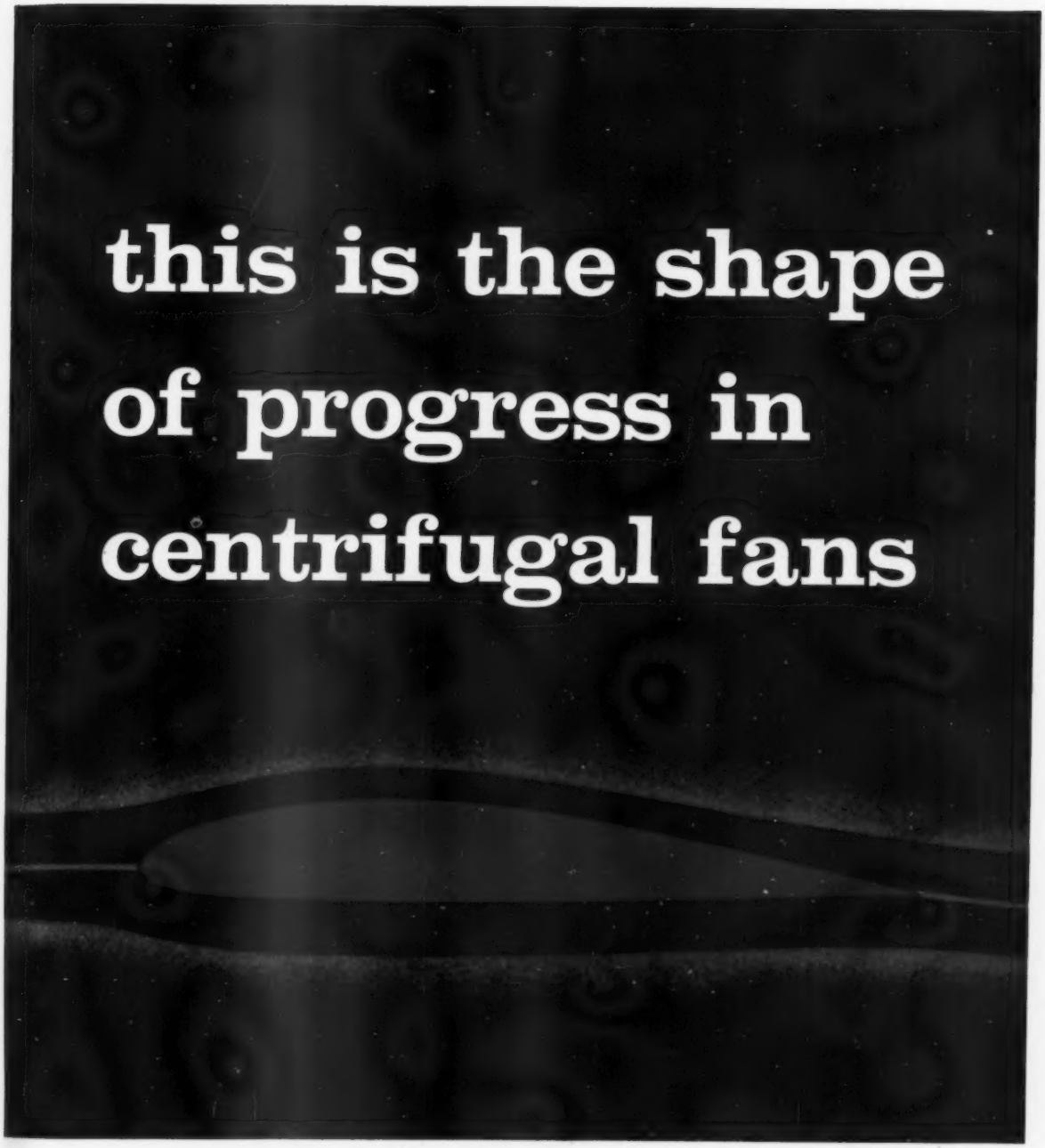
A Change that Would Work Wonders

My strongest conviction centers around the fact that our government is overlooking one method of supplying foreign aid which could easily prove to be the most effective of all, and would be a boon to our hard-pressed taxpayers. The way to build up industrially underdeveloped countries, effectively and on a grand scale, is to construct industrial plants financed jointly by American and foreign investors. If Pakistan or India wants to build a paper plant, for example, its construction might be financed partly by American capital and partly by local capital. The foreign country would be provided with the needed capital, the technical design work, and the knowledge of operation that is necessary to assure a successfully run plant. This plan would have the merit of being of equal benefit to the foreign country and to our own economy – and at the same time would be a terrific stimulant to the private enterprise of American venture capitalists. Everyone concerned would profit.

Our own experience in foreign countries supports the belief that this plan would work. We are engaged in ventures in India, Pakistan, and Iraq, all of which are being operated as joint enterprises with local engineers. A vital phase of each project involves the training of native men to play an increasingly important role in the design, construction, and efficient operation of large plants.

By the use of these methods – the hand-in-hand partnership of American private capital and brains

(Concluded on page 368)



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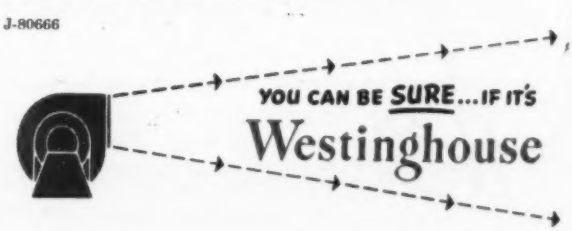

OUR FOREIGN AID

(Concluded from page 366)

with foreign on-the-spot capital and talent, and the training of native skilled workers with complete confidence in their resourcefulness – I believe the goal of our Foreign Aid program can be achieved more surely and at a fraction of the present cost. If an additional incentive is needed to attract more American capital, the government could easily provide it by allowing a tax exemption of 10 or 15 per cent of corporate profits invested in approved foreign industries. In the exemption now permitted for South American investments, there is ample precedent for such tax consideration. The policy should be broadened to apply to every foreign country approved under our program.

With this final spur to participation by our American capitalists, we would look forward hopefully to the day when our magnificent humanitarian program for the benefit of the underdeveloped countries will be carried on successfully without the huge outlay of government funds. Let our businessmen run the program as businessmen, in close and friendly association with the businessmen of foreign lands, and they will prove to be the selling agents of free enterprise to the rest of the world. They will win the admiration and respect of both business and government leaders in foreign-aid countries. Under such a plan, before long we will be able to count foreign-aid nations among our staunch friends and allies.

BEYOND NUCLEAR PHYSICS

(Continued from page 358)

enough to circle a football field. It will be located in an underground, circular tunnel building with earth-fill above for shielding the high-energy radiations. The magnet will be powered 60 times per second, and in each cycle a beam of electrons will be injected and accelerated to high energy. Beams of particles and radiations from targets will emerge from the tunnel through channels in a thick concrete shielding wall and traverse a large experimental laboratory, in which the scientific experiments will be set up.

High-energy electrons were chosen, rather than protons, to exploit their unique differences and advantages. They will produce a forward directed beam of gamma rays of up to six Bev energy on striking a target in the circular vacuum chamber, which gamma-ray beam will emerge tangentially into the experimental laboratory. The extremely sharp beam will have great advantages in experiments. Energies and intensities will be sufficient to produce large numbers of strange particles, of all types. The production process of forming strange particles by gamma rays is inherently simpler in a theoretical sense, so analysis of the results may have great significance.

The field of particle physics is basic research. There is no known area of practical application at present. The motivation of the university scientists is the search for knowledge about nature, at one of

(Concluded on page 370)

SPECIAL REPORT

Mr. JAMES THOMAS McCREARY NEW YORK LIFE AGENT

at SAN FRANCISCO, CALIFORNIA

BORN: July 30, 1915.

EDUCATION: Butler University, B.S., 1938.

MILITARY: U.S. Navy, April '42—January 3, '46--Lt.

PREVIOUS EMPLOYMENT: 1938-1942—Insurance Sales.

REMARKS: On December 28, 1945, while still on terminal leave from the Navy, James Thomas McCreary joined New York Life's San Francisco General Office. His fine business and educational background, combined with a pleasant business manner, helped Tom McCreary become one of the Company's leading agents. Honors bestowed on him include continuous membership in New York Life's Top Club, the President's Council—an organization composed of the Company's top 200 sales leaders. And his outstanding achievements have qualified him for membership in the industry-wide Million Dollar Round Table every year since 1947. Well liked and respected by clients and associates alike, Tom McCreary can very well look forward to many more years of success with the Company he serves so well.

Note

Tom McCreary is now solidly established in a career with the New York Life Insurance Company that can offer security, substantial income, and the deep satisfaction of helping others. If you'd like to know more about such a career for yourself as a representative of one of the world's leading insurance companies, write:

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BEYOND NUCLEAR PHYSICS

(Concluded from page 368)

the extreme frontiers of science. The challenge is dramatic to an extreme, and advanced students are flocking into this field of science for their graduate studies and thesis problems. The university is a proper location for such basic research, but because of the large apparatus requirements it is necessary to seek governmental support. All of us in the scientific departments and the institutional administrations are aware of the essential need to keep the scientific planning and management free from stultifying governmental controls. The Atomic Energy Commission has acted with wisdom in providing for complete university control of the scientific program, which will be supervised by a joint committee of M.I.T. and Harvard scientists and administrative representatives of both universities.

So this is what lies beyond nuclear physics — the nature of matter itself. We are just at the threshold of exciting new discoveries about the fundamental particles of which the world is composed. The purpose is knowledge for its own sake. And if, in the future, some useful application to human needs comes from these beginnings, it will only be repeating our past experience and will again justify our faith in the ultimate utility of basic research and the search for knowledge.

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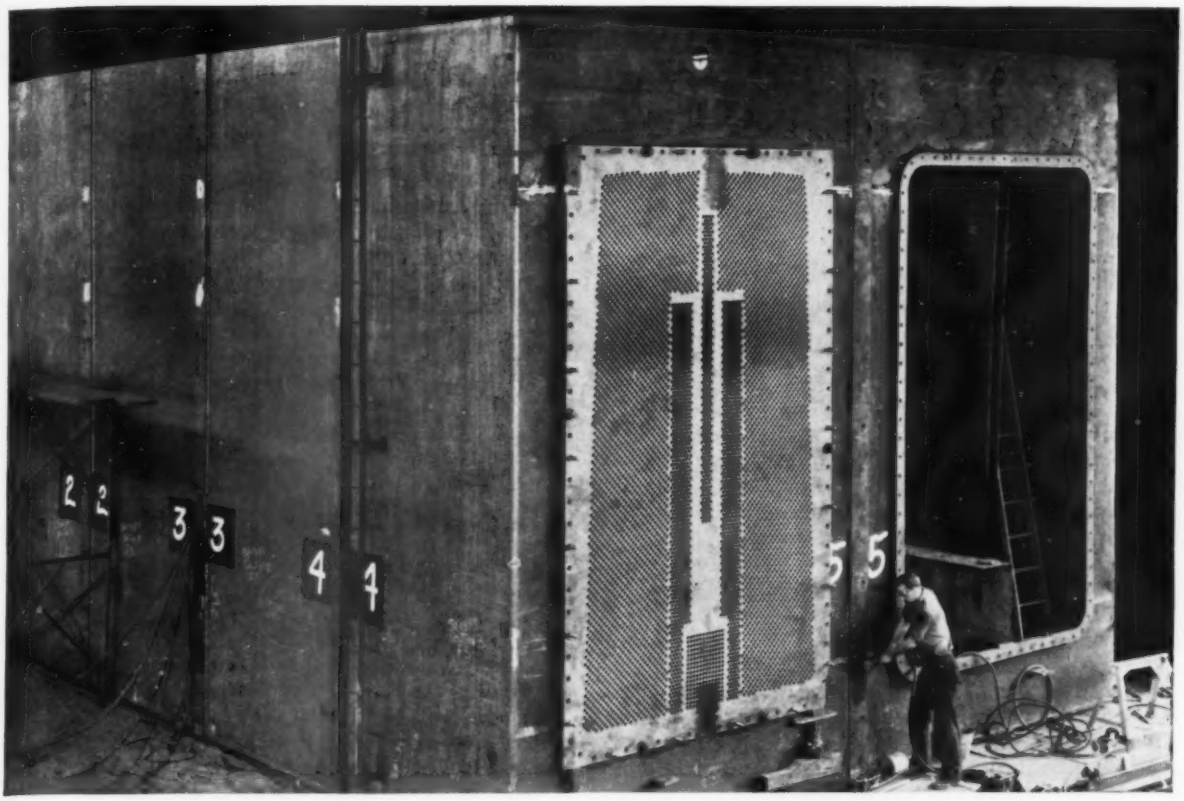

HERE'S ONE SHELL of this twin-shell, triple-lane unit just before shipment to Consolidated Edison's Astoria Station. It's designed to condense 1,600,000 lbs. steam/hr. at 1.87" Hg., with 244,000 gpm circulating water, and has 27,450 aluminum-brass tubes. Unit serves 335,000 kw turbine.

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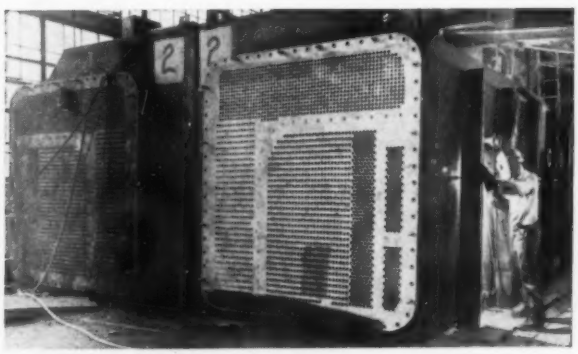
VICE-PRESIDENTS LEE YETTER and Roy Droescher, and Chief Engineer Paul Hamm are responsible for the design and construction of all Wheeler condensers. They work with engineers employed by C. H. Wheeler's customers, with turbine manufacturers' engineers and consulting engineers in BTU chasing.



TYPICAL REVERSE FLOW CONDENSER is this 35,000 sq. ft. unit for a Southern electric utility. Patented Reverse Flow feature permits flushing debris from tubes with only slight (and momentary) vacuum loss. Note low height to save head room, rectangular cross section to further utilize space for this Wheeler client.

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ROLE OF THE ENGINEER

(*Concluded from page 352*)

of pulling together whole groups of disciplines into a new common effort.

And now, thirdly, we come to the heart of the debate. How much basic science shall we infuse into the education of an undergraduate engineer? How far shall we go in discarding all the drafting and design, the shop and more practical, immediately useful professional subjects?

Here it is that each institution must make its own hard decision. There are thousands of boys in this country with an aptitude for doing, with a love for mechanical things, and with no mind for mathematics. There is and there will be work for them to do – mountains of work – work that is indispensable for the smooth operation of our great industrial machine. It would be folly to cram these heads with advanced calculus and quantum mechanics. Let us not waste and discourage this human talent, but rather direct a part of our educational effort – indeed perhaps the largest part – to their particular needs and ours.

But now in addition, let us also recognize that henceforth the vanguard of engineering, the great creative genius of the profession, will march forward hand in hand with science. The research engineer of the future may be concerned with the anatomy of components or the physiology of systems. His interest may center on materials, on fluid flow, combustion, or information theory. Whatever it may be, it is unlikely that in these areas he will make important contributions without benefit of a superb training in physics, chemistry, and mathematics.

As one observes the changing scene at M.I.T., it is apparent that increasingly our faculty is turning to these aspects of the new engineering as our own particular mission. We would, perhaps, be moving in this direction even faster, were it not for certain reservations, certain misgivings which I likewise share.

Because, for all the common ground, engineering is not and never will be science. There is inherent in the profession of engineering a whole set of attitudes and concepts that are completely foreign to pure science. The engineer must have a feel for materials, a concern for cost, an understanding of the factors of size and weight, an appreciation of the problems of maintenance and replacement; and above all, an unfailing sense of responsibility toward his client and the public good.

As we move steadily toward the scientific and theoretical in our engineering training, it seems to me of the utmost importance that we preserve the deep qualities of the profession. They are, in a very real sense, the humanities of engineering. I believe most earnestly in the importance of a liberal education. I find no conflict in the concept of undergraduate professional training that is both liberal and thorough. That is the kind of an undergraduate experience that M.I.T. aspires to give.

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AMERICAN SCIENCE AND TECHNOLOGY

(Continued from page 356)

Because science is required for the maintenance of military strength and because it has made spectacular contributions to the development of weapons, it has come to be thought of with disproportionate emphasis on its military significance. This distortion needs correction, and it is heartening to note current efforts to re-emphasize the humane values of science and to underscore its immense contributions to the good life and the good society. Through medicine – through the creation of a better environment – through its contributions to a higher standard of living and of life – through its enhancement of man's dignity by its enlargement of his understanding – through the values it has established for our society – science has come to be one of the great humane and constructive forces of our time.

The best description of science that I know comes not from a scientist but from a philosopher – Charles Frankel. "Science," says Professor Frankel in his eloquent book, *The Case for Modern Man*, "is an example par excellence of a liberal art – a deliberate, selective reordering of experience, which releases men from the narrowness and urgency of their routine affairs, carries them beyond the limitations and accidents of their lives, and makes it possible for their commerce with the world to have scope, order, and systematic consequences. It has been used as an instrument of . . . war, but its primary function is more humane and, as it were, aesthetic. And its relation to practice is the relation of any fine and liberating art – it carries men beyond the foreground of their experience, and enlarges the dimensions of human choice by acquainting men with the alternative possibilities of things . . ."*

And to this description can be appropriately added the following observation of Warren Weaver of the Rockefeller Foundation. The facts, he said, "do not support the concept of science as some sort of super creed, magical and mysterious as it is all-powerful, arrogant from its successes, and avid to invade and conquer, one after another, all the fields of human activity and thought. This viewpoint does not justify the notion that science is so special as to be unique, as well as so curious as to be incomprehensible. This does not depict scientists as strange creatures who are in one sense so objective, judicial, and precise as to be incredible, and in another sense so apart from life as to be selfish and sinister.

"On the contrary, these descriptive comments picture science as the servant of man, not his master; and as a friendly companion of art and of moral philosophy. This is a science that is the way it is because man wants it to be that way. It is a natural expression of both his curiosity and his faith."

(Concluded on page 376)

* New York: Harper and Brothers, 1956.

where the Mississippi flows east to west

. . . there along the northwest boundary of Illinois lies Rock Island County . . .

REFERRING to the bluffs along the river at this point, an architect told us one day that here are some of the finest home sites he has ever discovered.

ON THESE BLUFFS are located the residences of many industrial executives, business and professional people who work in the cities of Rock Island County. They like this metropolitan area of over one quarter million people. Life is interesting the year around. Outdoor activities, a variety of cultural and entertainment attractions and the friendly citizens make it so.

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L. to R., Tom Parker and Howard Soper of Parker-Soper, Architects; Dick Weldon

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AMERICAN SCIENCE AND TECHNOLOGY

(Concluded from page 374)

If we can make science understood in the terms of Frankel and Weaver, we can gain much for science and culture. We can still further break down the antagonism between the domain of science and the domain of the humanities and social sciences, with the result that both will join together to further man's wisdom and understanding. It is this concept of science as a servant of man, and as basically a humanistic discipline, that helps to strengthen my optimism about progress being real and technology benign.

It is important that this image of science be clearly seen, as well as its image as a builder of weapons. This is another objective, this image of science in its true humane proportions, that we need to achieve as we seek a balanced science program for the future and a proper place for science in our national life.

With these examples of some of the current opportunities and problems facing us, let me conclude by emphasizing the great responsibility which rests upon American science today in the light of the extraordinary opportunities which have been given to participate in the formulation of national policy. The growing linkage of science and technology with government demands of scientists a new order of poise, steadiness, and statesmanship. The current emphasis on science, if it is not to cause reactions adverse to science, also requires of the scientific community humility and a sense of proportion. It requires of scientists a recognition that science is but one of the great disciplines vital to our society and worthy of first-rate minds; a recognition that science is a partner – sharing and shouldering equally the responsibilities which vest in the great array of professions which provide the intellectual and cultural wealth of our society.

In touching, however, superficially, upon the special responsibilities of scientists to walk humbly as their responsibilities increase, I also am expressing my faith in the growing opportunity of science not only to deepen our understanding and enlarge our views of the world – not only to enhance our sense of beauty and order – not only to augment our power and wealth – but also to minister humanely, benignly, and responsibly to the needs of our fellows, our government, and our country.

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They are men like you — men chosen for their fine education and background. All received thorough training and earned while they learned. Now they are established in a career that uniquely combines independence with stable income—plus the security of group insurance and retirement benefits.

If you would like to know more about this opportunity, write for a free copy of "A Selling Career".

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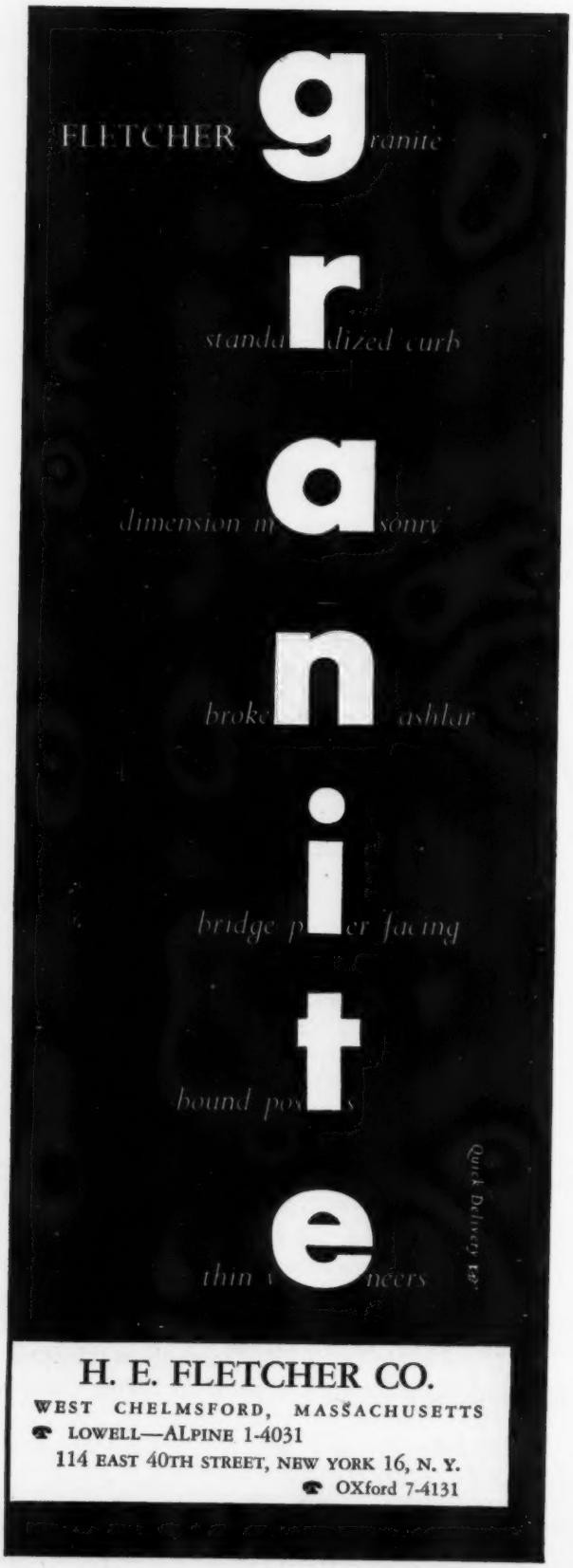

TREND OF AFFAIRS

(Continued from page 350)

Mr. Kispert's final set of figures pertained to scholarship aid. As the tuition increase goes into effect, the Institute plans to increase undergraduate scholarships in greater proportion than the tuition increase. Approximately 25 per cent of the undergraduates will be receiving tuition awards averaging $1,100 per year. Graduate fellowships financed by M.I.T. will also be increased in greater proportion than the rise in tuition. Compared with some other private institutions, M.I.T. shows up relatively poorly on scholarship aid. However, the Institute has the largest and probably the most successful Loan Fund in the country. This has decreased the need for a larger amount of funds being put into undergraduate scholarships. At the present time M.I.T. lends about $400,000 a year to undergraduates. The Loan Fund will be modified to provide loans to the freshmen for the first time in its history. Including scholarships and loans which M.I.T. provides to undergraduates, Student Aid amounts to 29 per cent of tuition, as compared to 16 per cent in 1940.

In closing, Mr. Kispert stated his personal conviction that all private institutions must begin to set tuition rates so that the tuition will cover a higher proportion of the total academic cost. This would not seem to be a practical move until new ways of providing large amounts of student aid are found. Much attention is now being given, both at M.I.T. and at other institutions, to various proposals of long-term repayment of tuition, and other means of achieving long-range financing of higher education.

In his talk on modern surveying, Professor Miller stated that, in the Department of Civil Engineering, extensive research has been conducted in the application of photogrammetry and electronic computers to civil engineering problems. New aids in surveying include precision cameras for aerial photography, microwave measuring devices in place of the customary optical transits and steel tapes, stereoscopic devices for plotting contours directly from aerial photographs, and high-speed digital computers for carrying on many laborious calculations needed in civil engineering. Almost all states and probably 100 civil engineering firms currently utilize electronic computers for some of their long, tedious calculations. By providing the computer with sufficient numerical representation of a particular terrain, the computer itself can be used to establish alternate highway routes or dam locations, and perform the necessary calculations to ascertain the estimates of the relative costs of various routes – taking into account even such factors as the type of soil and the valuation of the property. By taking advantage of instrumental developments initiated in other fields, the civil engineer is enabled to concentrate on performing his truly professional role. Professor Miller's talk was well received and gave Council members new concepts of modern methods of mapping the earth's surface.

(Concluded on page 380)

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* These MIT men hold important and worthwhile positions with Sangamo Electric Company:

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TREND OF AFFAIRS

(*Concluded from page 378*)

Cosmic-Ray Shower Experiment

■ The largest cosmic-ray shower experiment ever attempted will be set up by M.I.T. physicists in New Mexico next June. Financed by a two-year grant of $134,000 from the National Science Foundation, the experiment itself will sprawl over 2,500 acres of the Volcano Ranch, 15 miles west of Albuquerque. The M.I.T. men will cover this huge area with 76 plastic scintillation counters and associated electronic equipment, linked together by 40 miles of coaxial cable. With this equipment the scientists will measure the size of cosmic-ray showers striking the earth, and the energies of the primary cosmic-ray particles that caused them.

The installation of the giant M.I.T. air shower experiment in New Mexico will be started in June and will probably be completed in September, at which time the experiment proper will begin. Analysis of the data gathered in New Mexico will be done mainly at M.I.T. Dr. John D. Linsley, Assistant Professor of Physics, will be in charge of the experiment and will remain in New Mexico until September, 1959. Dr. Linsley's chief associate will be Livio Scarsi, who is on leave from the University of Milan as a Fellow in the School for Advanced Study at M.I.T.

The M.I.T. physicists are looking for clues that may help solve important problems in astronomy, nuclear physics, and cosmic-ray research. The M.I.T.-New Mexico experiment will be an extension of an earlier experiment carried out at Harvard, Mass.

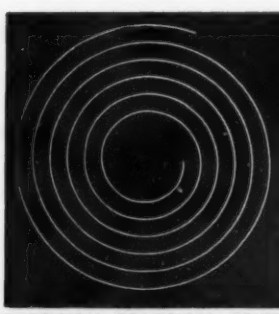
MAIL RETURNS

(*Continued from page 334*)

favorite "old saw of the scientists," is not nearly as serious as those which follow.

Second, United States policy-makers have not been very wise, nor have they generally been well advised in the field of aviation, going way back, but, again, particularly during the past five years. The late President Roosevelt toyed with model battleships on his desk while the late General "Billy" Mitchell talked to him about aviation. The spectacular advent of World War II literally forced an aviation program upon the nation, almost too late. President Truman was aided by some out-

(*Concluded on page 382*)



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MAIL RETURNS

(*Concluded from page 380*)

standing lawyer-statesmen with an interest in aviation, men like Lovett, Forrestal, Foster, Symington, Finletter, and McCone. However, during the past five years, when the impact of aeronautics on our security and economy has been the greatest in our history, President Eisenhower did not have a single Cabinet-level adviser with outstanding competence in the field of aeronautics, until the belated appointment of an assistant for Aviation Facilities Planning.

Third, among the many eminent scientists who have served in lower-level policy jobs in government, for example, as chairman of the Defense Research and Development Board of Assistant Secretary of Defense for R. and D., there has never been an outstanding aeronautical scientist. Furthermore, until relatively recently, there was only one man with an aeronautics background on the President's Science Advisory Committee.

Fourth, while aeronautics has been having its greatest impact on our lives, outstanding leaders in aviation have been largely content to ignore their responsibilities for "conveying their message" to their fellow citizens. By way of comparison, the physicists, for example, through the *Bulletin of the Atomic Scientists,* have accepted their broader social responsibilities and have become an important force in United States policy-making. On the other hand, the aeronautical scientists still talk mainly only to themselves; for example, during the past 12-year history of the Institute of the Aeronautical Sciences, the writer recalls only one three-hour session dealing with the social impact of aviation.

These four main reasons, and many others equally important, have had together a great retarding influence on the progress of aeronautics in this country. Dr. Blizard has spoken of only one of them.

However one might differ with the presentation, Dr. Blizard certainly does deserve to be warmly congratulated for bringing up for discussion a very important subject in the field of aeronautics. One would hope to see the discussion continued through contributions from aeronautical scientists, whose acceptance of a greater measure of social responsibility is rather overdue.

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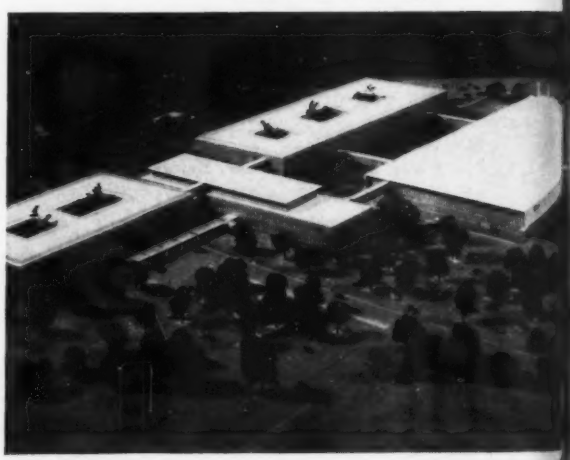

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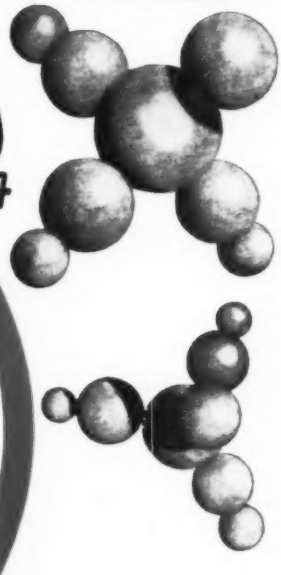

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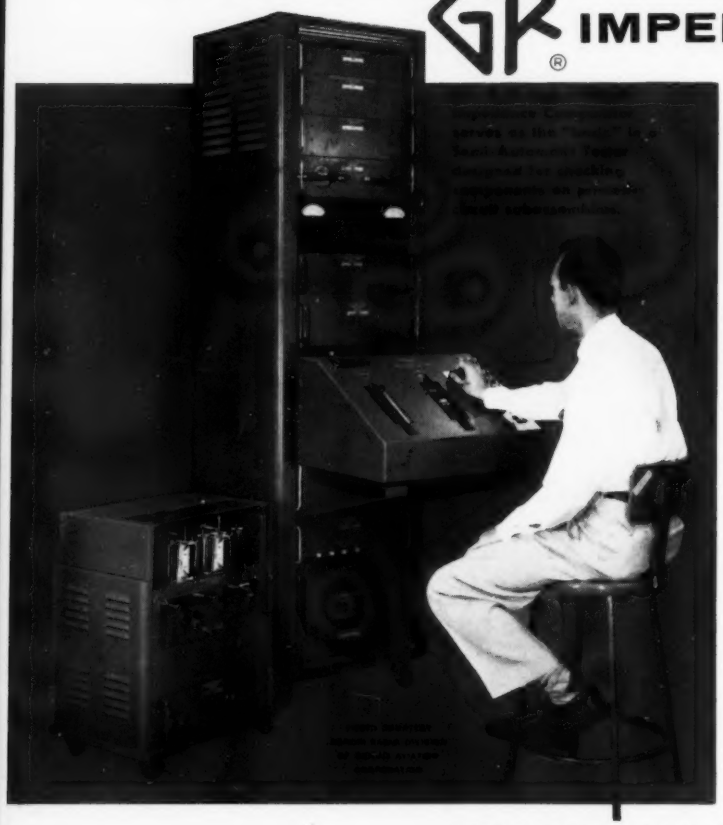

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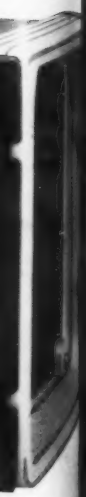

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